INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT

ANDHRA PRADESH ELECTRICITY DEVELOPMENT NUMBER

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EMC

Preformed

Armour Rods

increase uninterrupted service life of conductor in High Tension Lines

The wind blows, the conductor vibrates and the life of your line is at stake. Severe frequency of vibration, if sufficiently prolonged, could begin to break the conductor regardless of the protective armour used. EMC PREFORMED Armour Rods have a big advantage over other armour : the rods undertake the function of an electrical and mechanical splice.

All armour rods greatly reduce the vibration stresses, but if vibration is severe enough to cause strand breaks, other types will not prevent parting of the strands. With EMC PREFORMED Armour Rods, it's different : the conductor is held tightly and uniformly throughout the entire length of the rods —not at one point. You have a long, firm grip that never relaxes, that maintains conductivity in spite of the break. The line continues to function unimpaired.

Another big advantage is that PREFORMED Armour Rods do not require ferrules to clamp the conductor at the ends—nor any press or wrenches to twist around. It is so simple that even a layman can apply it on the conductor without any chance of committing mistakes.

EMC introduces the latest development in Transmission Line Materials—PREFORMED—under special arrangements with Preformed Line Products, Inc., of Cleveland, U.S.A.

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ELECTRICAL MANUFACTURING COMPANY LIMITED

You can look up to Preformed

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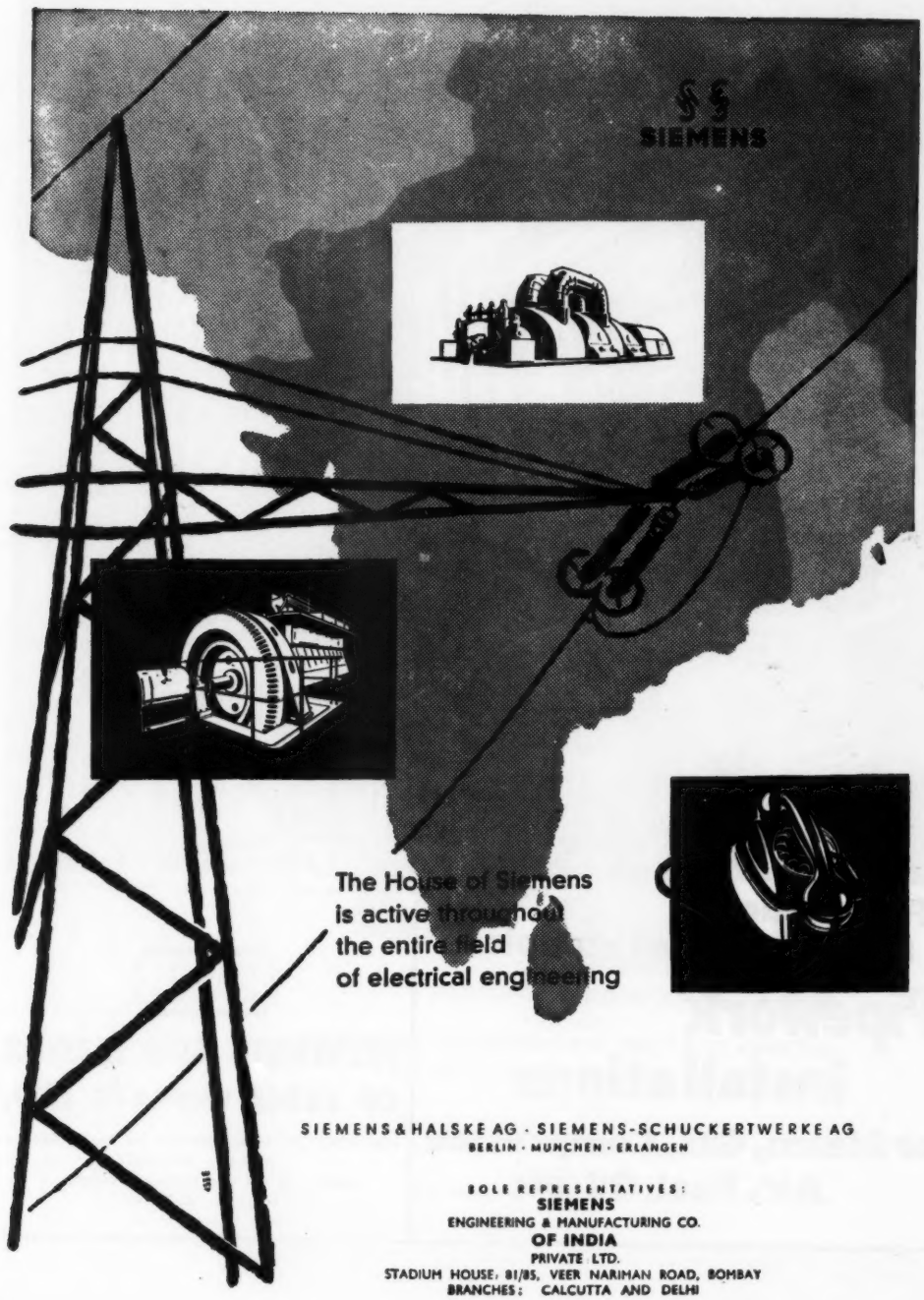

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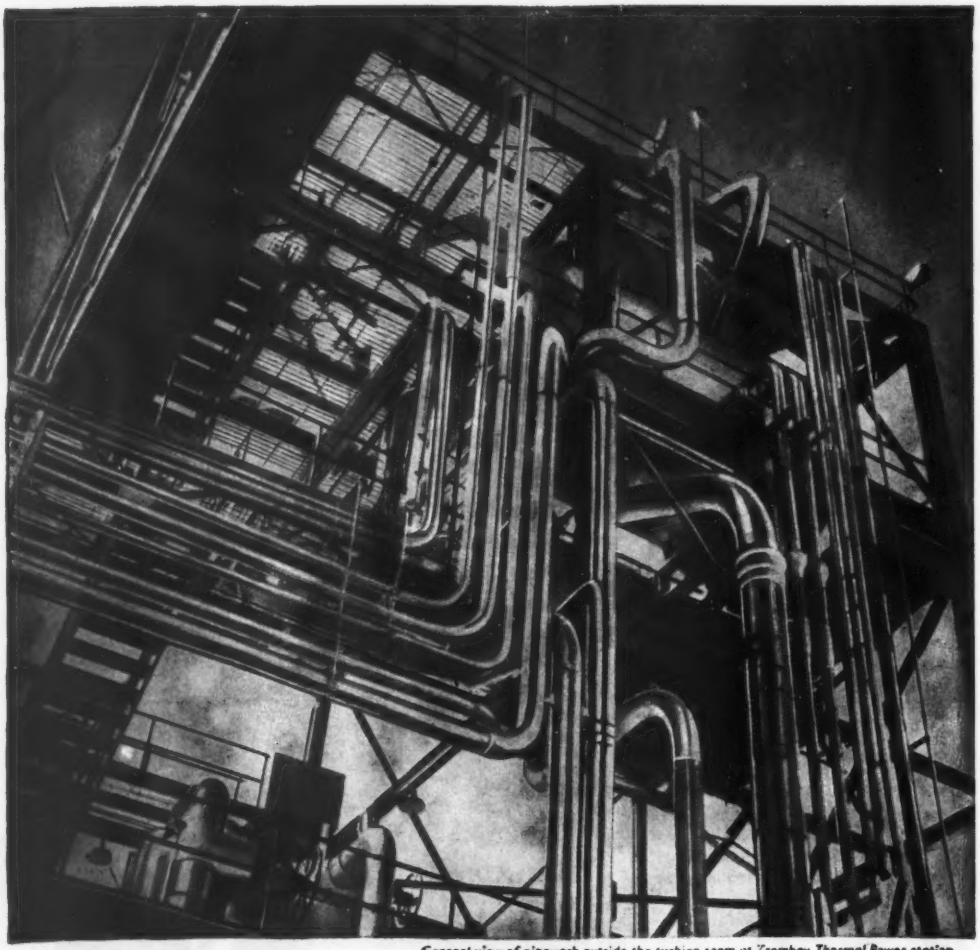

General view of pipework outside the turbine room at Trombay Thermal Power station

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for Steam, Gas, Compressed Air, Fuel Oil etc.

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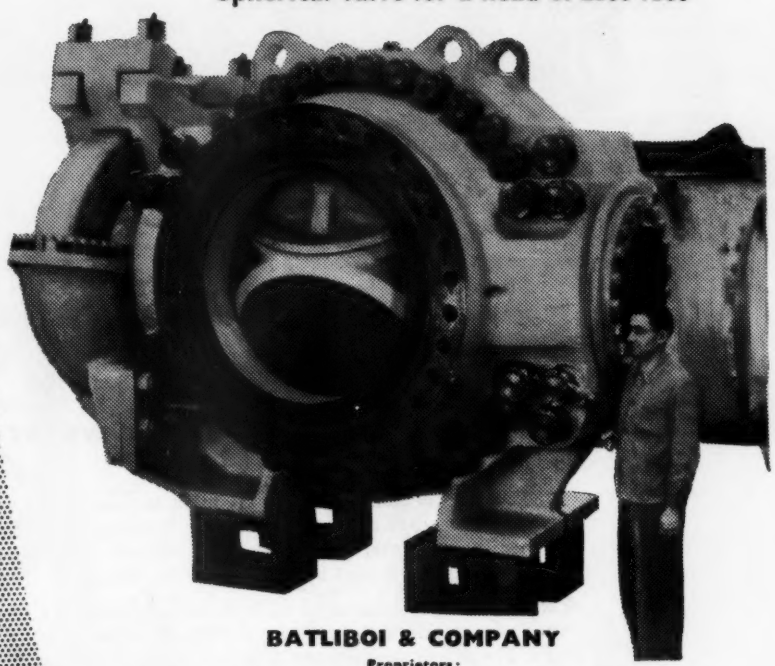

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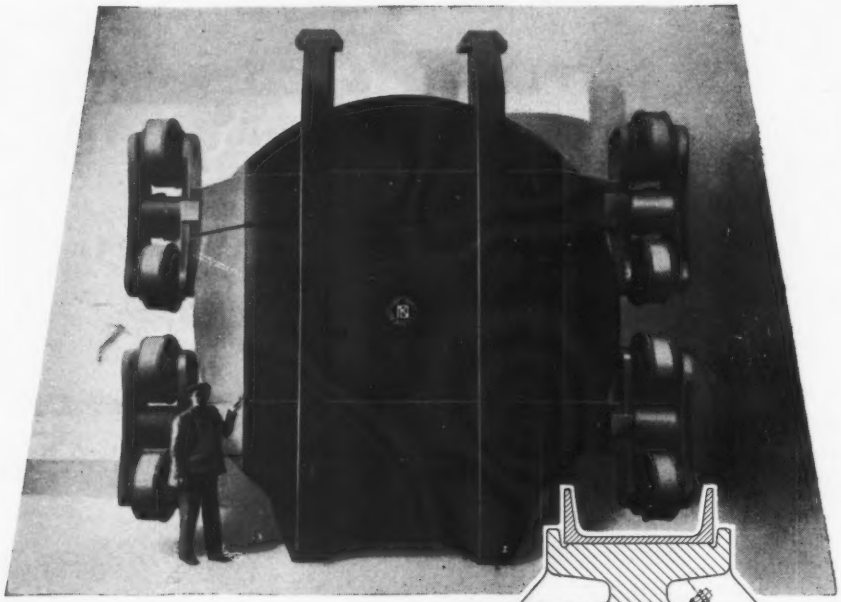
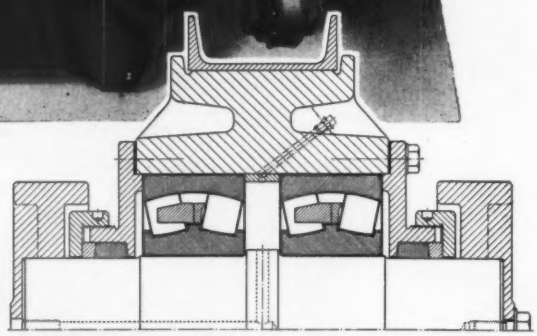




SKF BEARINGS

in Weir Gates — 155 ft. under water

SKF Spherical Roller Bearings are fitted to four sliding weir gates used in the regulating dam on the river Esla at Ricobaya, Spain, which were built in 1935 by Boetticher y Navarro, S.A., Madrid, and are part of the power station installation owned by Iberduero S.A., Bilbao.

Each gate has a diameter of 14 ft. 6 in. and weighs 32 tons. The gates are fitted at each side with two pairs of flanged rollers, which run between guide rails. The rollers are mounted on SKF spherical roller bearings, which were chosen for this task because they are easy running, require only a minimum of maintenance, and can be sealed effectively against water.

The maximum height from the centre of the gates to the surface of the water is no less than 155 ft., and the sealing devices of the bearing application consequently have to withstand an enormous pressure. Nevertheless, the bearings are giving *complete satisfaction even today — 17 years after fitting.*

THE SKF BALL BEARING CO. PRIVATE LTD.

BOMBAY. P. O. BOX 71 CALCUTTA, P. O. BOX 588 MADRAS, P. O. BOX 66

power

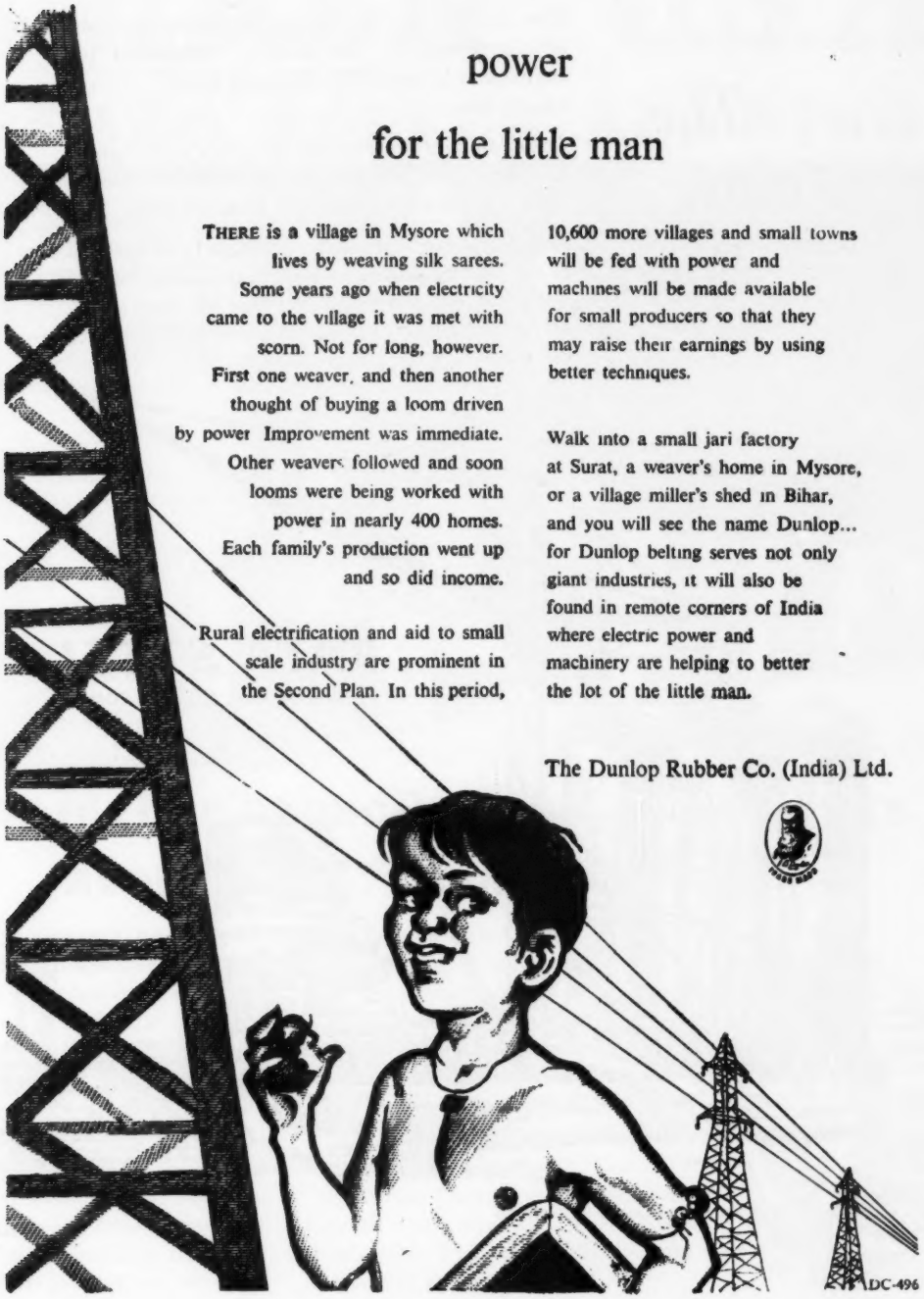
for the little man

THERE is a village in Mysore which lives by weaving silk sarees. Some years ago when electricity came to the village it was met with scorn. Not for long, however. First one weaver, and then another thought of buying a loom driven by power Improvement was immediate. Other weavers followed and soon looms were being worked with power in nearly 400 homes. Each family's production went up and so did income.

Rural electrification and aid to small scale industry are prominent in the Second Plan. In this period, 10,600 more villages and small towns will be fed with power and machines will be made available for small producers so that they may raise their earnings by using better techniques.

Walk into a small jari factory at Surat, a weaver's home in Mysore, or a village miller's shed in Bihar, and you will see the name Dunlop... for Dunlop belting serves not only giant industries, it will also be found in remote corners of India where electric power and machinery are helping to better the lot of the little man.

The Dunlop Rubber Co. (India) Ltd.



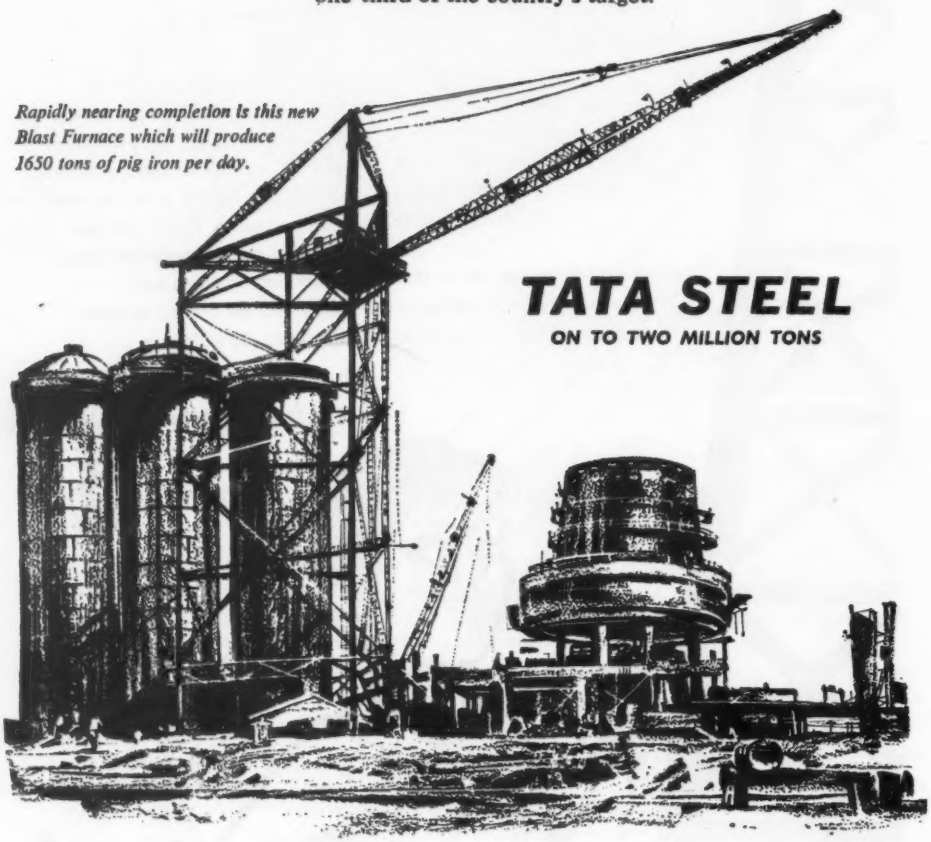
DC-496

The Final Spurt

Tata Steel's two million ton expansion programme is now entering the final phase. Scheduled for completion by mid-1958, it is now a race against time.

Today all over Jamshedpur there is a new sense of urgency . . . work goes on round-the-clock to complete the expansion programme on time.

Embracing every phase of operation from the winning of ore and the mining of coal to the rolling of steel, Tata Steel's expansion programme will double the annual production to two million tons of ingot steel—one-third of the country's target.



Rapidly nearing completion is this new Blast Furnace which will produce 1650 tons of pig iron per day.

TATA STEEL

ON TO TWO MILLION TONS

THE TATA IRON AND STEEL COMPANY LIMITED

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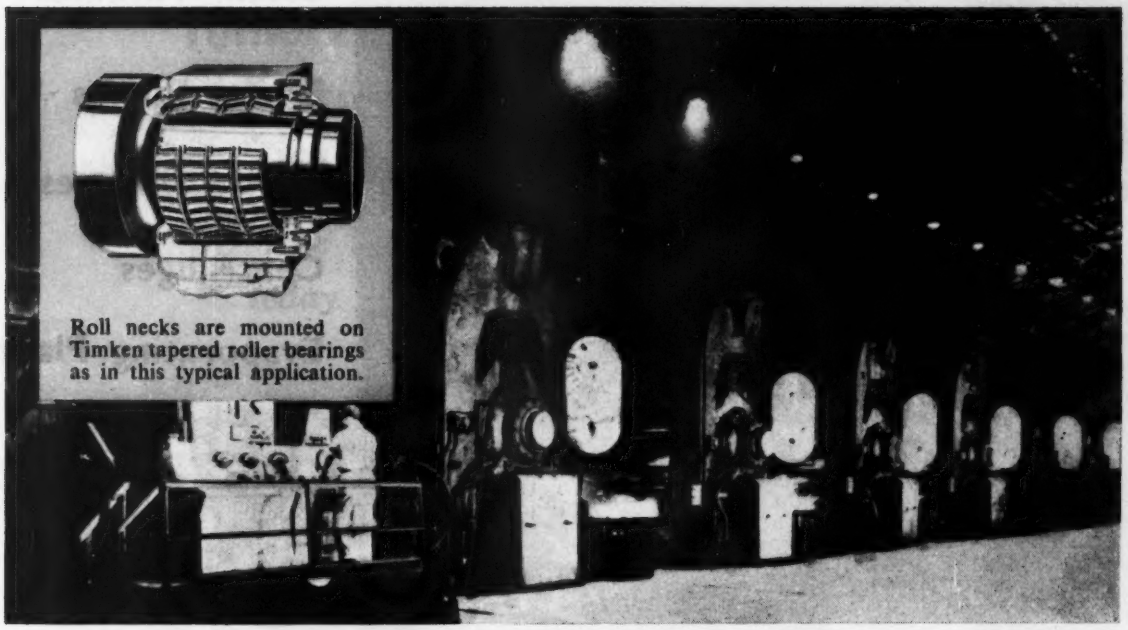
TIMKEN *Made in* U.S.A.

TRADE-MARK ORIGINATED, OWNED, REGISTERED BY THE TIMKEN ROLLER BEARING COMPANY

TAPERED ROLLER BEARINGS

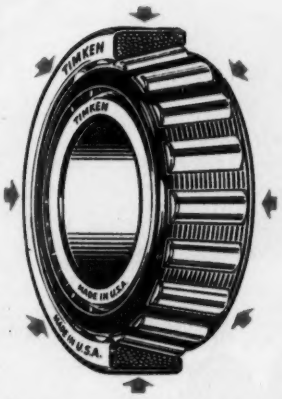


Roll necks are mounted on Timken tapered roller bearings as in this typical application.

New higher capacity Timken Bearings average 75% more tonnage

TO cut costs per ton of steel rolled, a large American steel maker installed a new design of Timken made-in-U.S.A. tapered roller bearings on the work rolls of the continuous hot strip mill above. Because of increased radial and thrust capacity, these new bearings averaged 75% more tonnage in the fixed position.

More than 650 mills in the United States use Timken bearings because: 1) *They eliminate extra thrust devices.* The taper lets Timken bearings take both radial and thrust loads in any combination; 2) *They cut lubricant cost.* Grease-lubricated Timken bearings eliminate complicated lubricating systems—no large amounts of oil, no tubes, piping, reservoirs; 3) *They assure longer bearing life.* We make Timken bearings from our own fine alloy steel. And we case-carburize rollers and races to give hard, wear-resistant surfaces and tough, shock-resistant cores.



Insist on Timken made-in-U.S.A. tapered roller bearings. *World-Wide Availability.* The Timken Roller Bearing Company, Canton, Ohio, U.S.A.
Cable: "TIMROSCO".

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⟨⟩ AND THRUST →⟨⟩← LOADS OR ANY COMBINATION

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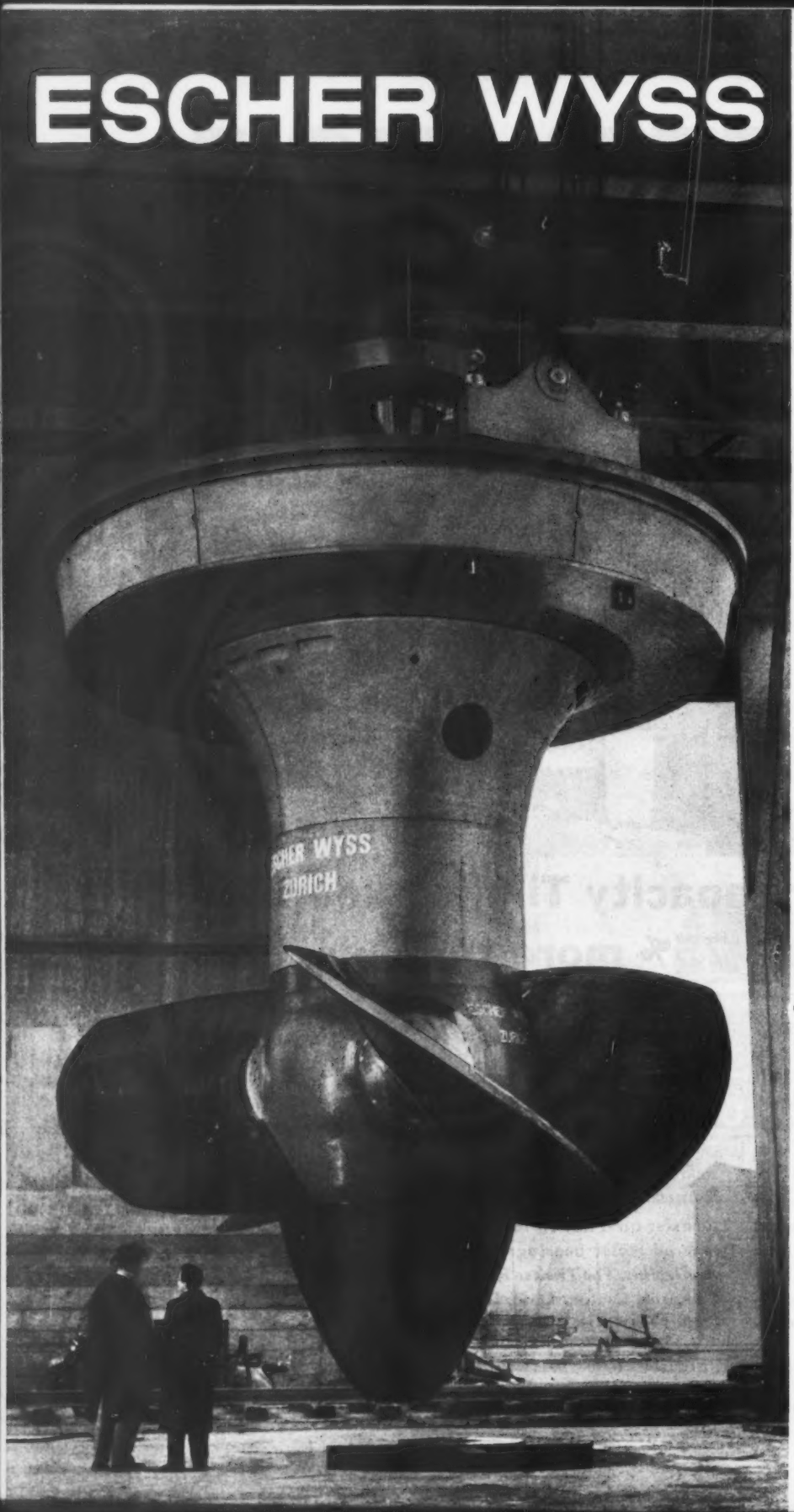

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For Tungabhadra Dam Power Houses
We have Supplied :
2 Vertical Kaplan Turbines each of 13800 BHP under 88 ft. net head.
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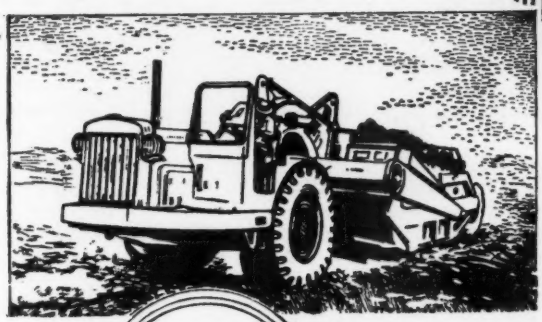
Tomorrow's fertile farmlands

can be built today by



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CATERPILLAR*

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To reach our goal of self-sufficiency in food production, millions of acres of arid land are being reclaimed for cultivation. Huge dams are being erected, miles of canals are being dug and vast tracts of land being cleared and levelled.

In all such major projects, construction engineers and contractors everywhere invariably rely on Caterpillar equipment for their rugged strength and versatility.

CATERPILLAR* *Paving the way to India's progress*

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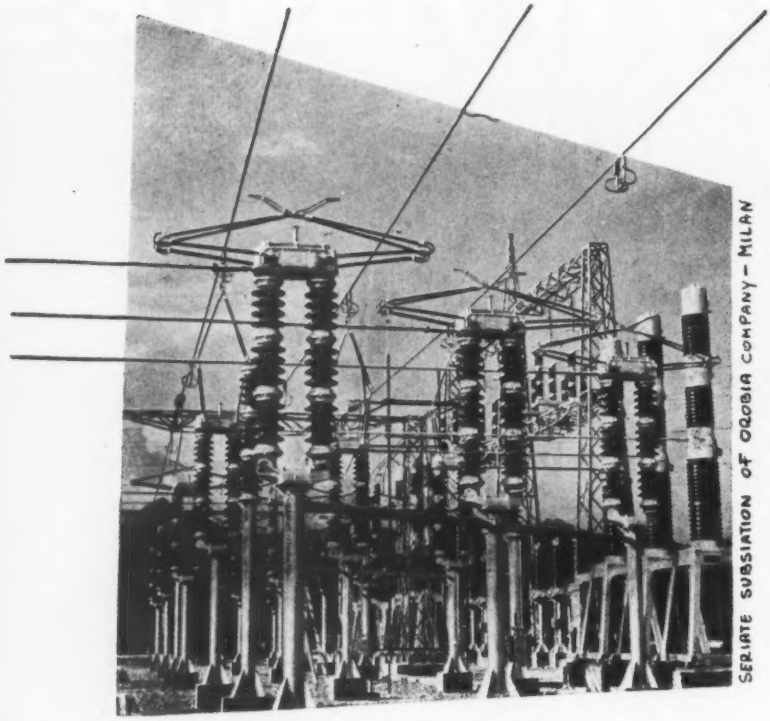
SERIATE SUBSTATION OF OROBIA COMPANY - MILAN

pantograph isolators

SCARPA & MAGNANO

Savona - Italy

HYDRAULIC-BRIDGE-ABOVE GROUND-STEEL CONSTRUCTION

CANADA-DAM

21 RADIAL SPILLWAY GATES WITH GANTRY CRANE AND MECANICAL EQUIPMENT 1954

LOUIS EILERS

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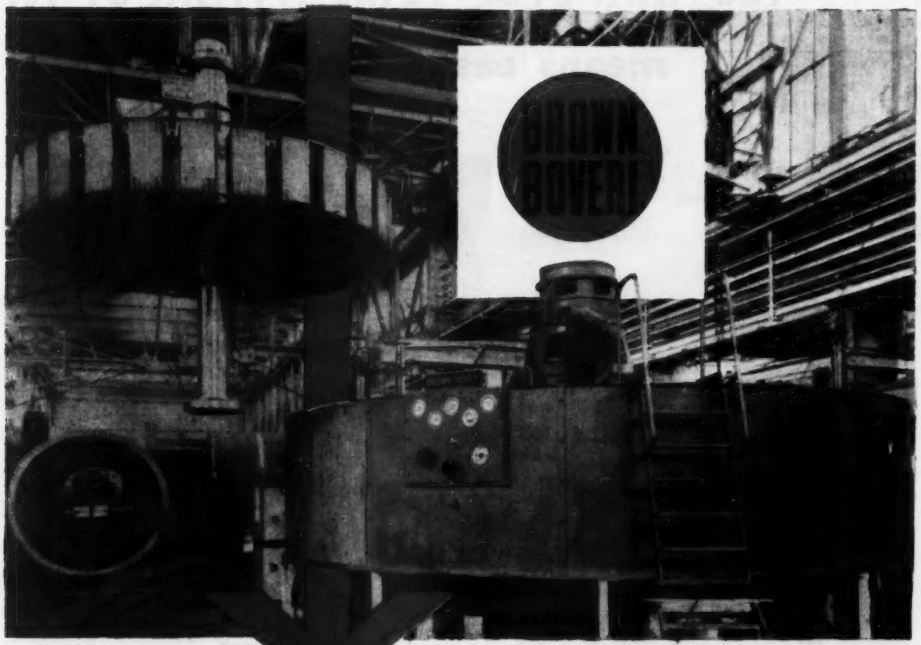

BROWN BOVERI WATERWHEEL GENERATORS

A view of the assembly, at the Works of Brown Boveri & Co., Ltd., Baden (Switzerland), of one of the two generators supplied to the Tungabhadra Dam Power Station. The generators were commissioned during the first half of 1957. Output: 10600 kVA: Voltage: 11000 V; Speed: 214 r.p.m.

Some of the large Brown Boveri waterwheel generators at present under construction or being installed:

3 x 50	MVA	600	rev/min	(Mexico)
3 x 52.5	,,	428	,,	(Switzerland)
2 x 53.3	,,	500	,,	(Switzerland)
3 x 60	,,	750	,,	(Switzerland)
5 x 67	,,	500	,,	(Switzerland)
1 x 60	,,	600	,,	(Portugal)
1 x 75	,,	428	,,	(Norway)
4 x 80	,,	333	,,	(Switzerland)
2 x 10.6	,,	214	,,	Hampi Power House, Tungabhadra Project,
3 x 27	,,	600	,,	Machkund Project (Andhra Orissa).
3 x 17.65	,,	600	,,	Neriamangalam Power House (Kerala State).

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180° NON-STOP TURN WITHIN 31 ft.

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EUCLID S-12 SCRAPER

Euclid has incorporated many 'years-ahead' features into its line of overhung engine scrapers.

Here are some cost-trimming factors:

- Easy, fast, independent hydraulic control of all scraper functions... steps up the production cycle ... eliminates cable worries.
- Easy accessability to all major working parts...cuts service and maintenance time greatly
- Wide, shallow bowl with variable "job-matched" positioning of cutting edges...digs in fast...provides excellent boiling action...speeds up loading...means more pounds of payload.
- Large, wide-base tyres...provide unequalled flotation...unusual ability to pull through soft materials...carry big loads at high speeds... work where and when other scrapers are "grounded."

Assisting the Second Five-Year Plan

BLACKWOOD HODGE

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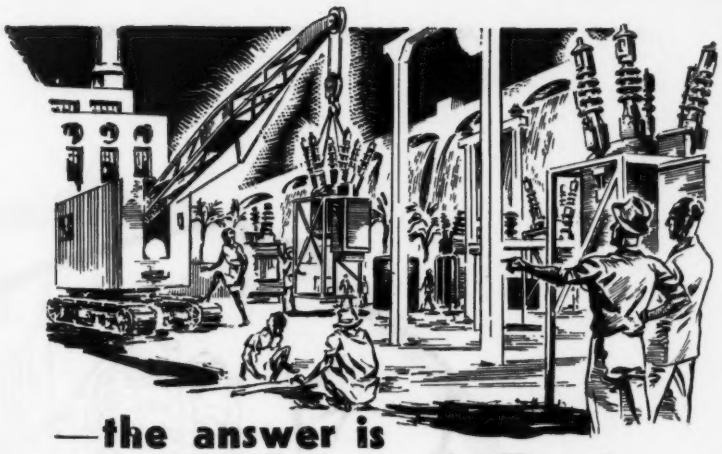
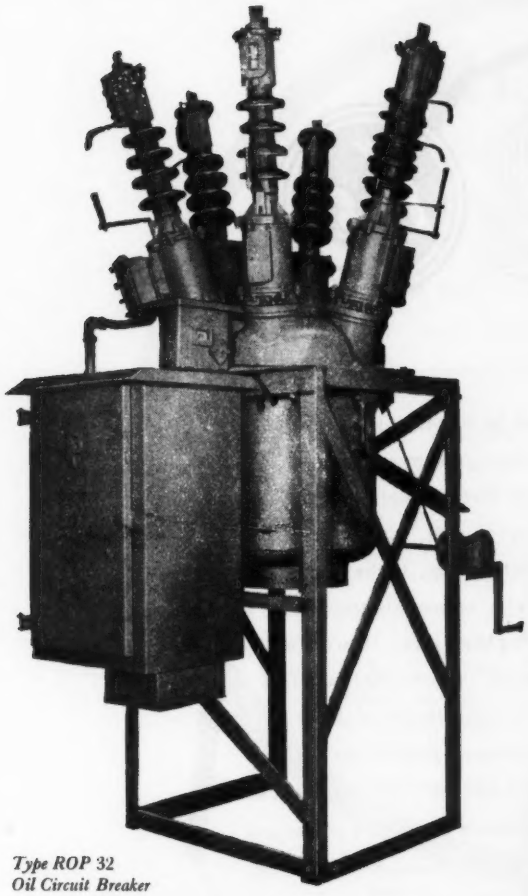
When the call is for SWITCHGEAR—



—the answer is *Ferguson Pailin*

When the dam is built and the major constructional work completed the task of installing the electrical plant and the equipment must be undertaken.

Ferguson Pailin have supplied switchgear for indoor and outdoor stations, including major hydro-electric schemes the world over. 'F. P.' is synonymous with first-class design, manufacture and performance of this essential equipment, ranging from extra high voltage switchgear for main grid supply systems down to low voltage switchgear for industrial purposes.



Type ROP 32
Oil Circuit Breaker

Two examples of 'Ferguson Pailin' switchgear, for varying duties, are illustrated here. They are :—

ROP 32 OIL CIRCUIT-BREAKER

Wherever 22 kV or 33 kV outdoor oil circuit-breakers for breaking capacities up to 750 MVA are required the merits of the 'ROP 32' breaker should be considered.

The design of this breaker provides for the optimum protection against adverse working conditions peculiar to countries in various parts of the world as well as maximum resistance to the effects of fluctuating temperatures and humidity.

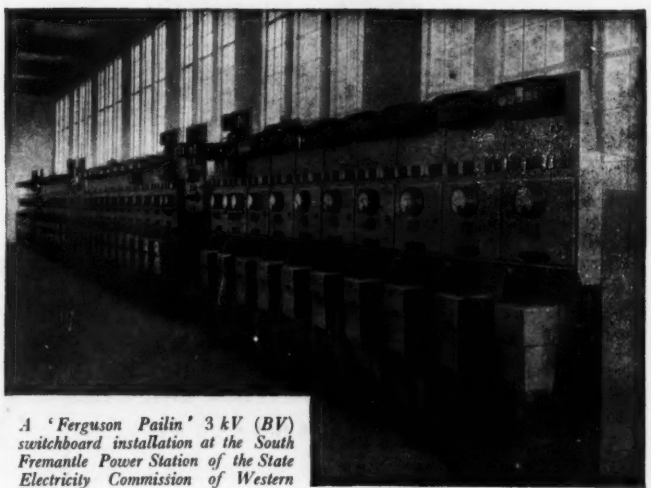
The versatility of the 'ROP 32' makes it remarkably adaptable to local requirements. Complete dependability and reliability make it a natural choice for incorporation into any scheme involving the transmission of power at 22 kV or 33 kV.

The circuit-breaker tank is of cylindrical shape and all three phases are brought into one tank, permitting the use of smaller framework thereby achieving compactness.

'BV' SWITCHGEAR

'Ferguson Pailin' Type BV switchgear is of the completely enclosed metalclad type. It is constructed on the unit principle and can readily be extended by units of similar rating, or by metalclad oil switches.

Vertical isolation of the breaker ensures minimum space requirements of the unit, whilst adequate interlocks safeguard against mal-operation.



A 'Ferguson Pailin' 3 kV (BV) switchboard installation at the South Fremantle Power Station of the State Electricity Commission of Western Australia.

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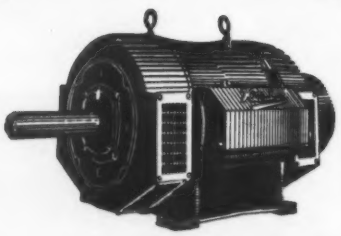

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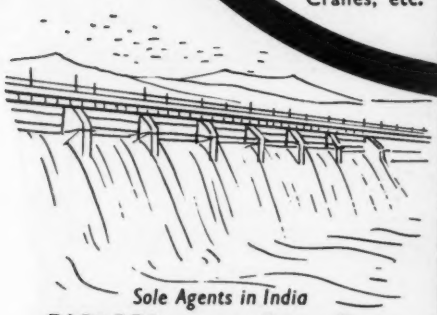

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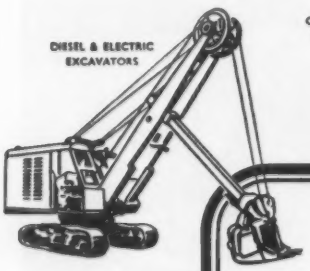

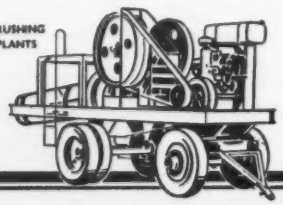

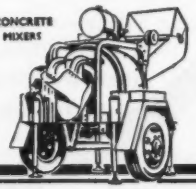

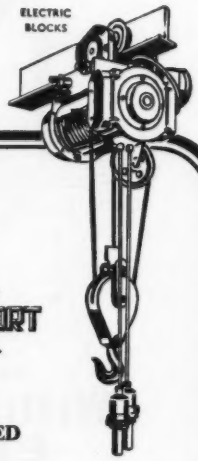

'Implementing'
the 2nd Five Year Plan...

We are proud to be associated with the industrial progress of India and are ready to contribute our mite towards the successful implementation of the 2nd Five Year Plan.

The implements and machinery manufactured by the world-renowned 'METALEXPORT' (Warsaw, Poland) are now at the service of our Nation. As pioneers in the production of every phase of industrial machinery—building or road construction machinery, air compressors or crushing machinery, flour milling, baking, or paper making machinery—METALEXPORT offers to supply the machinery requirements of our 2nd Five Year Plan adequately.

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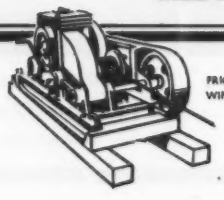

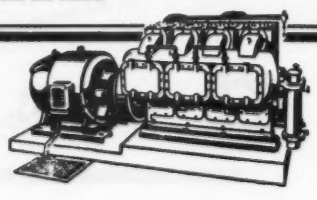

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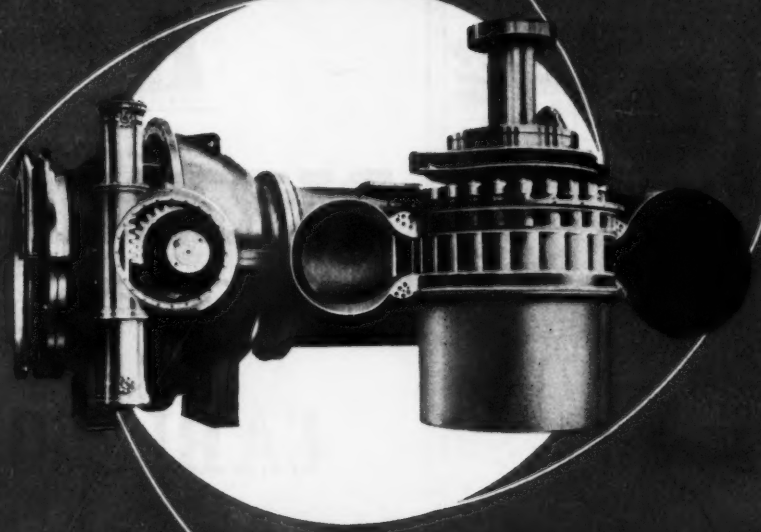

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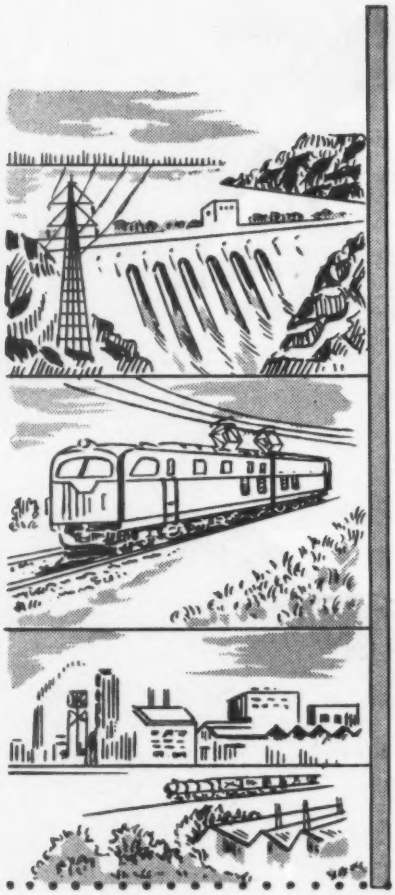

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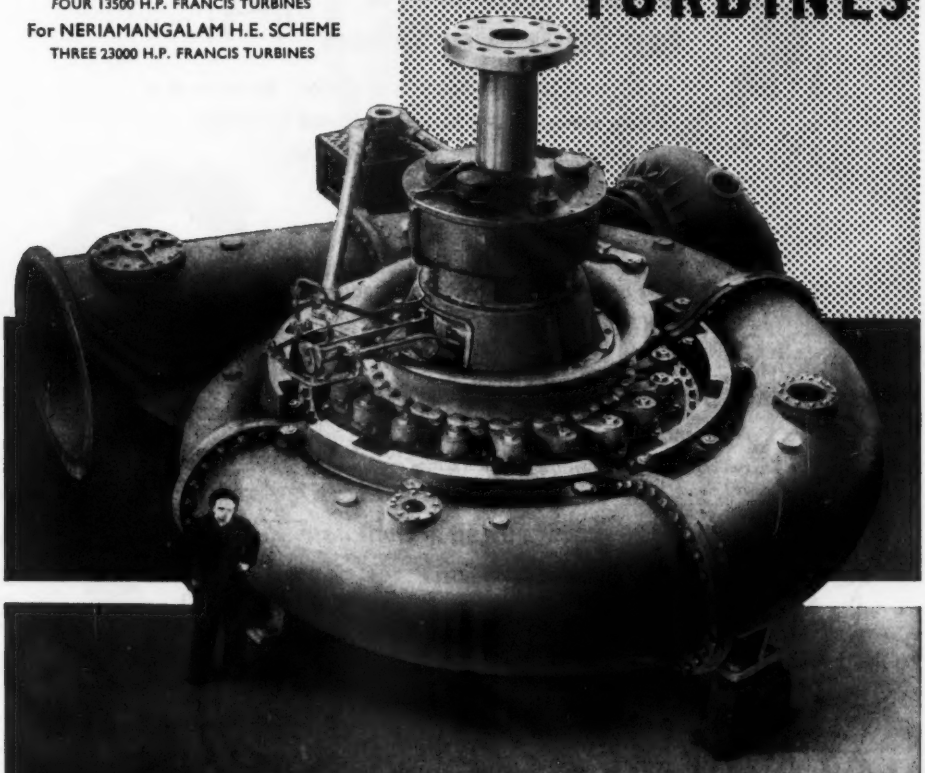

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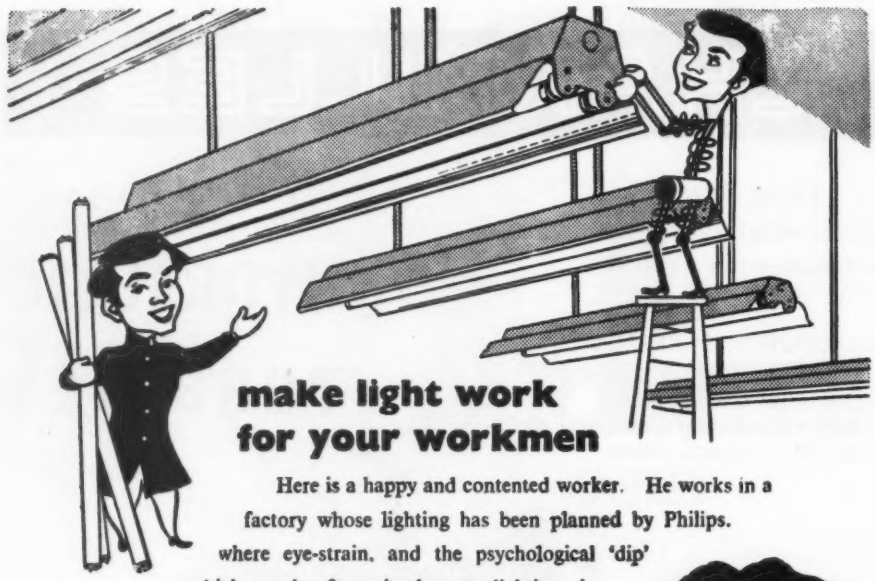

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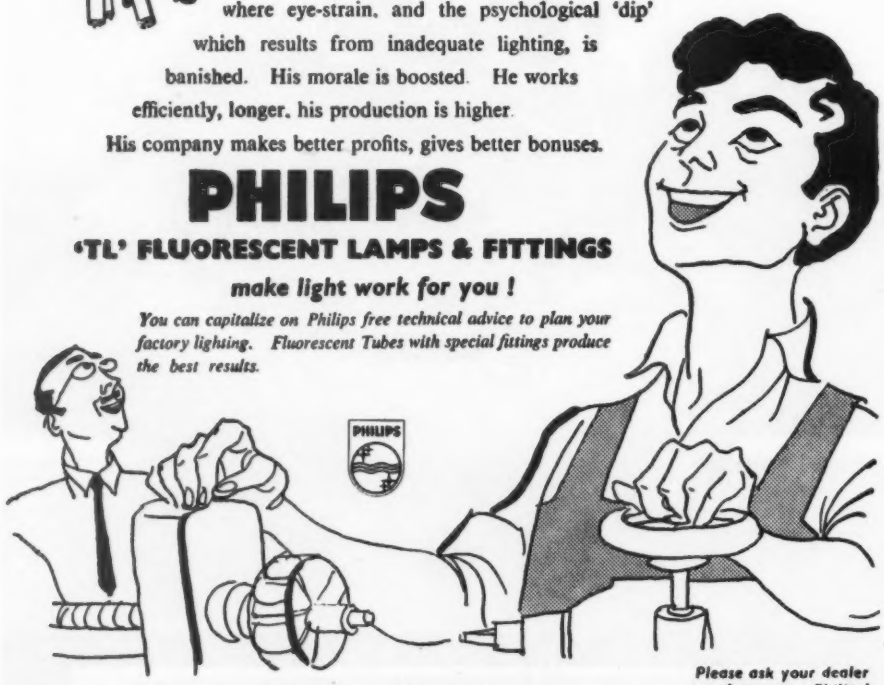

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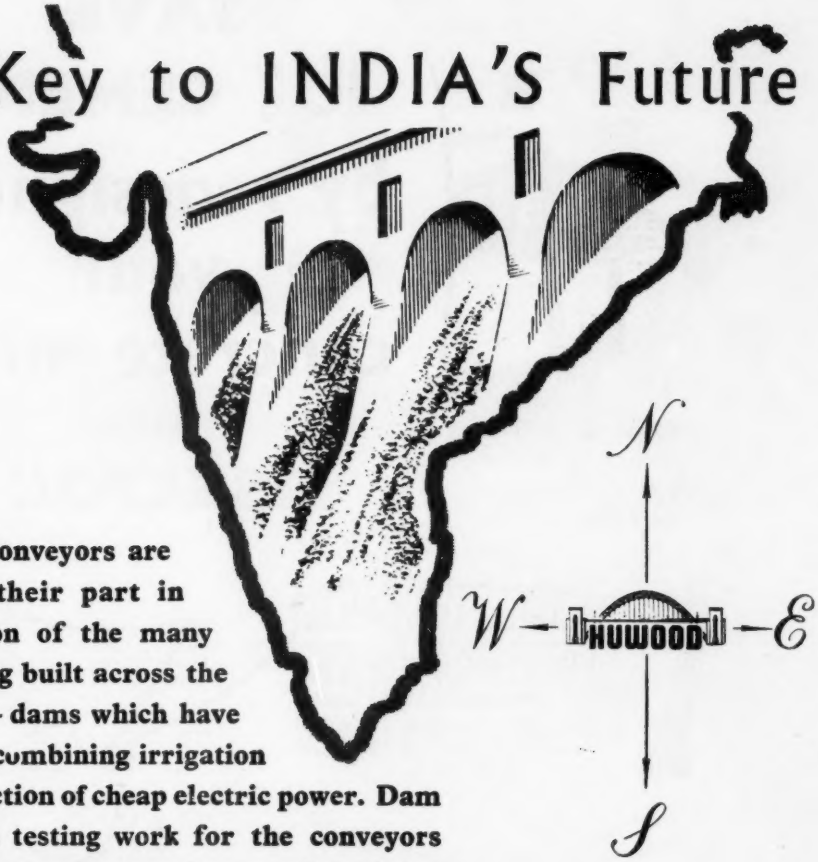

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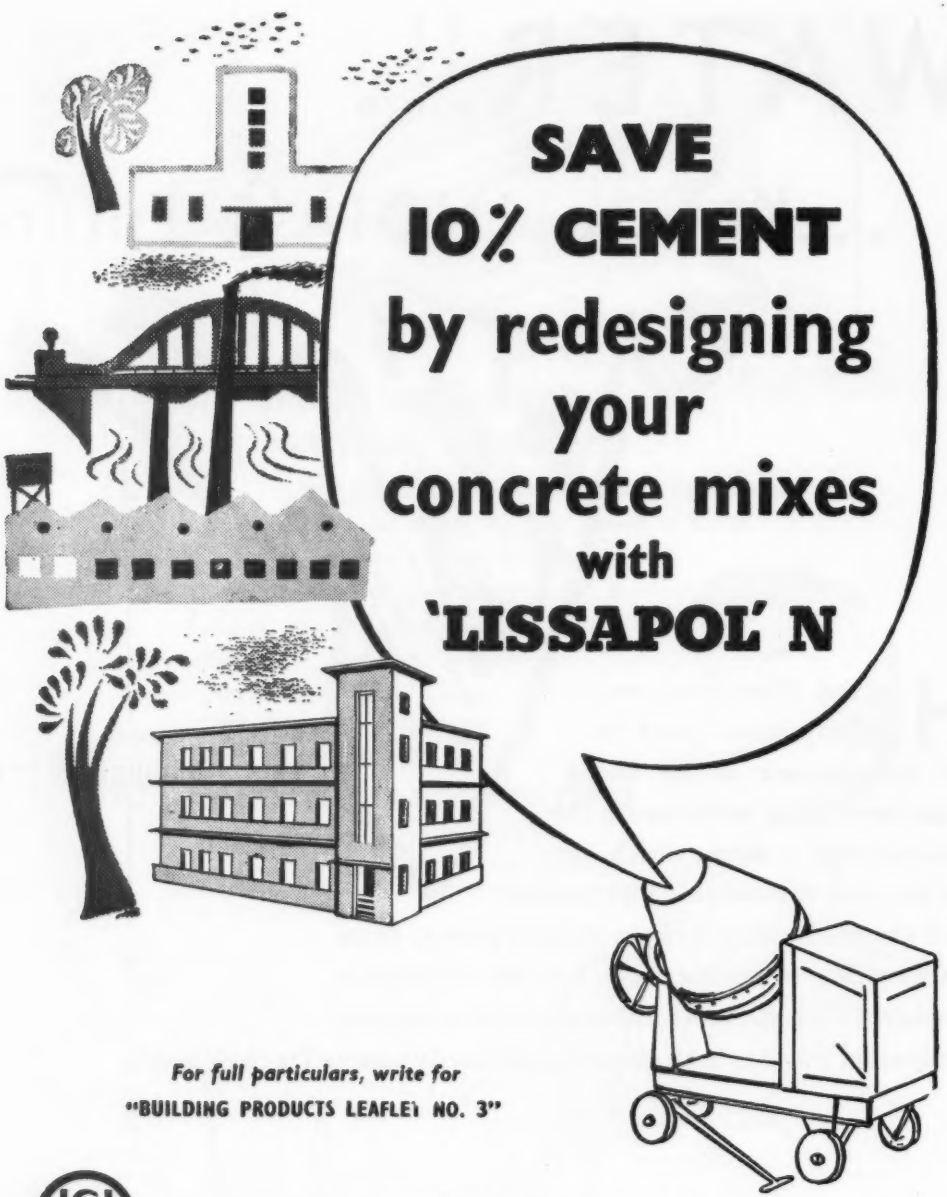

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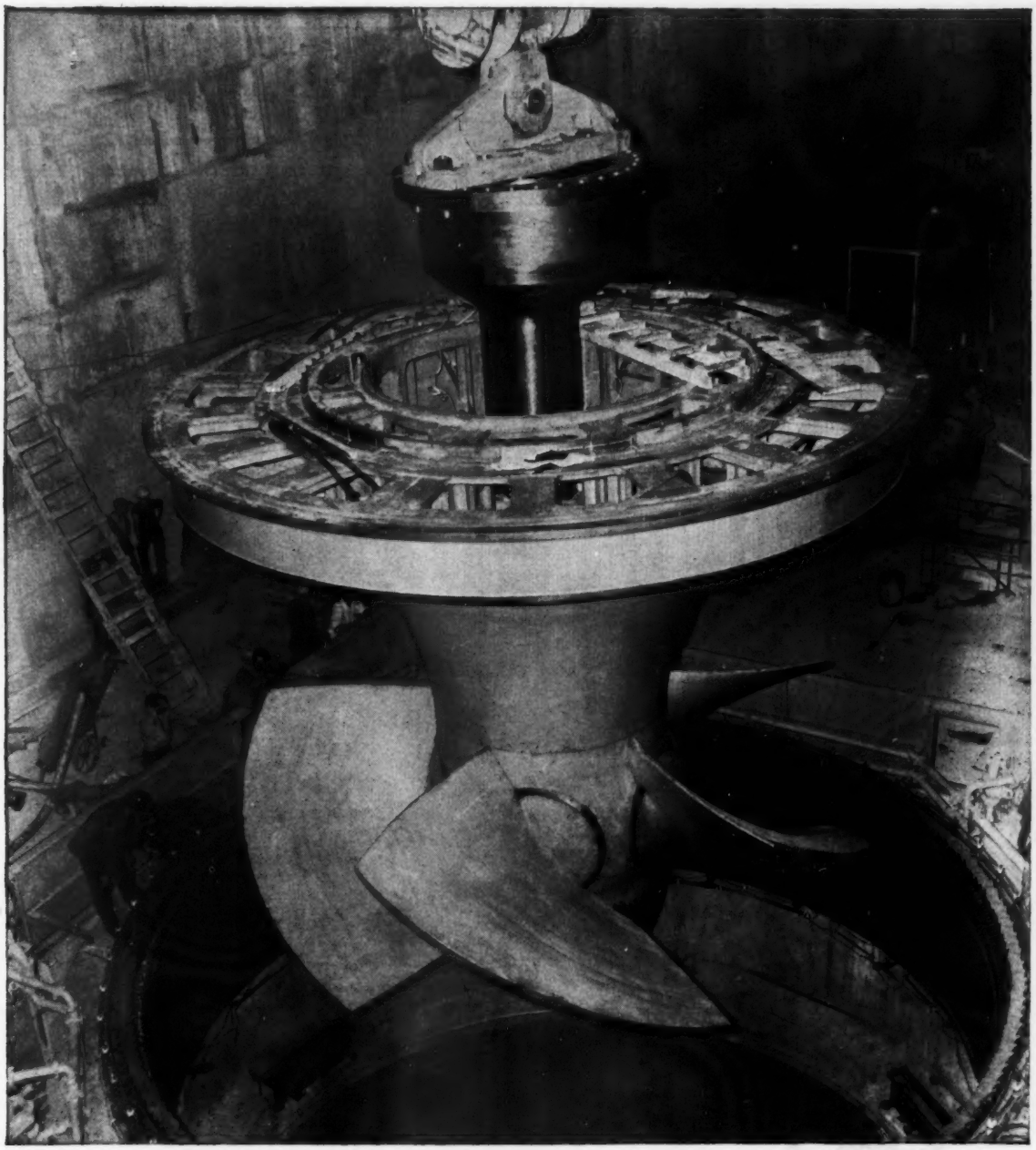

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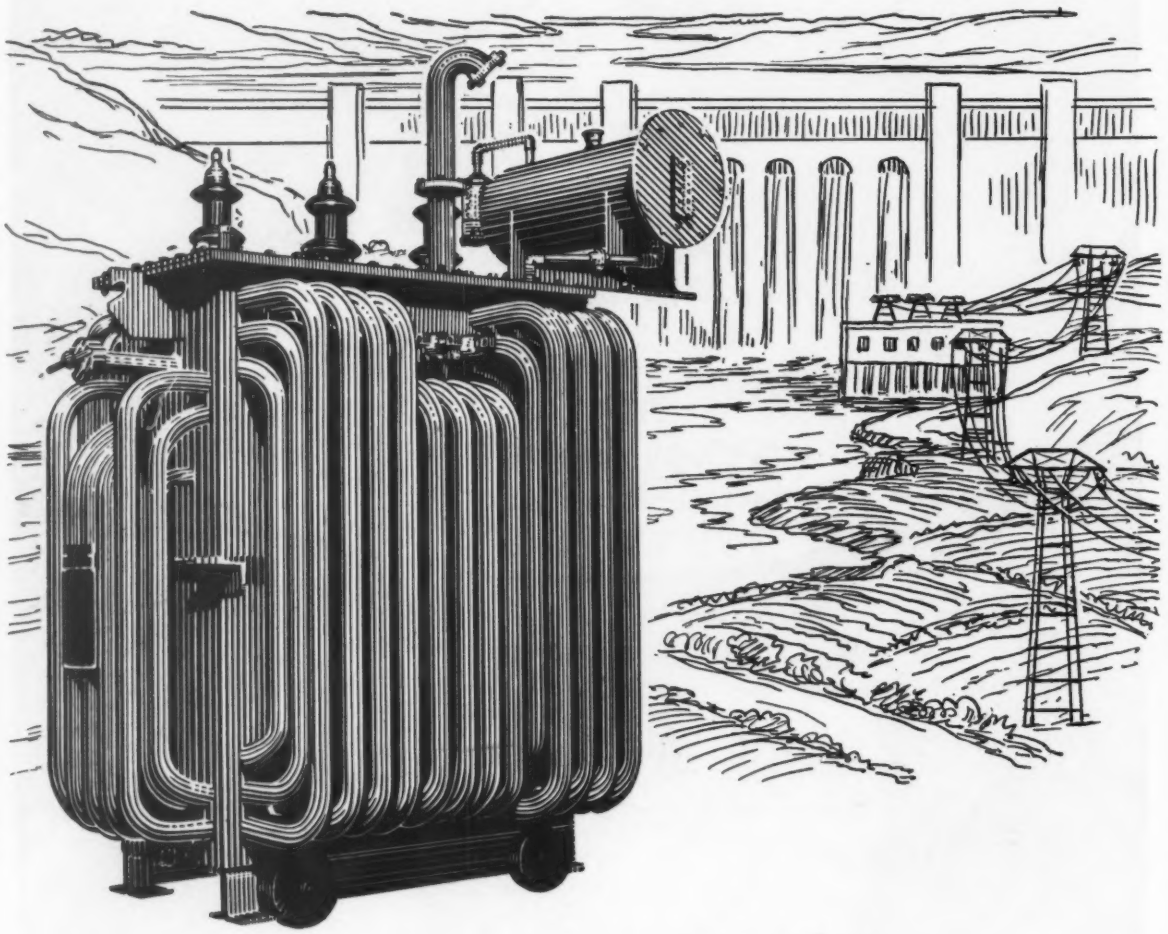

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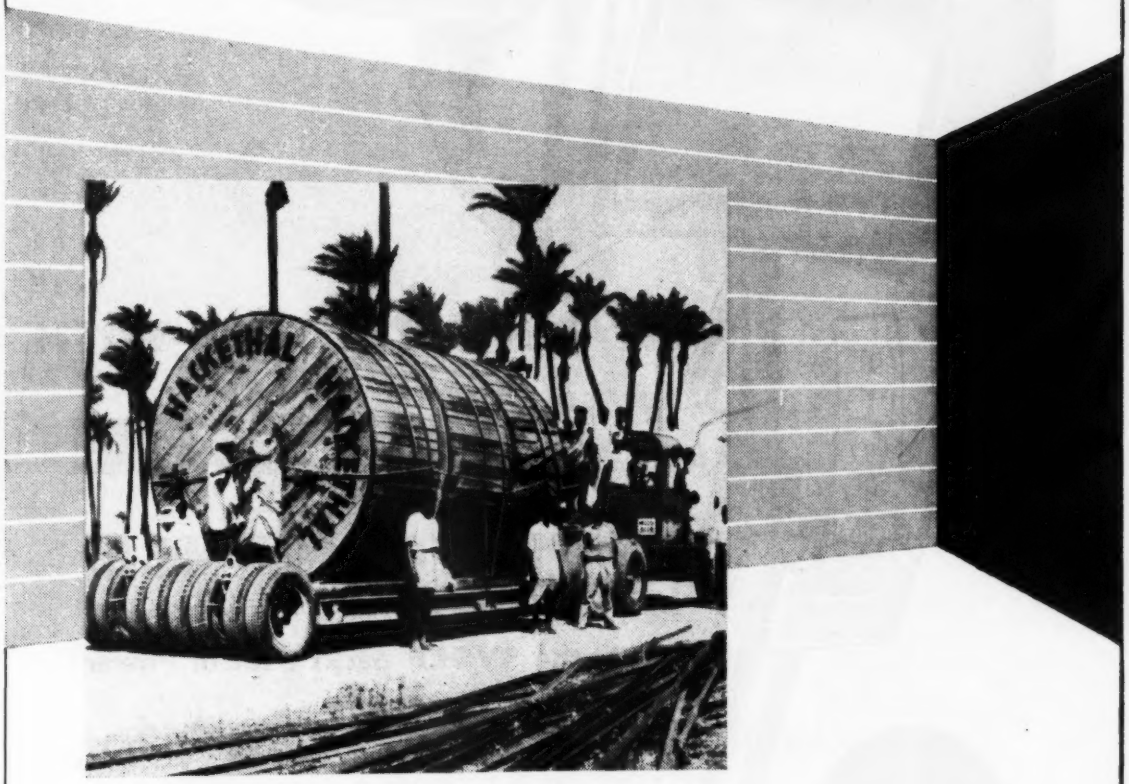

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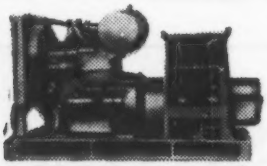

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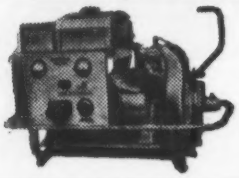

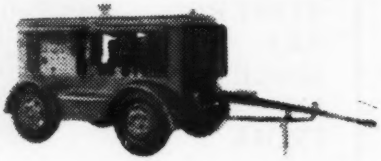

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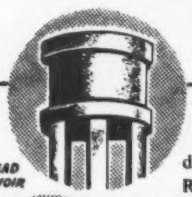

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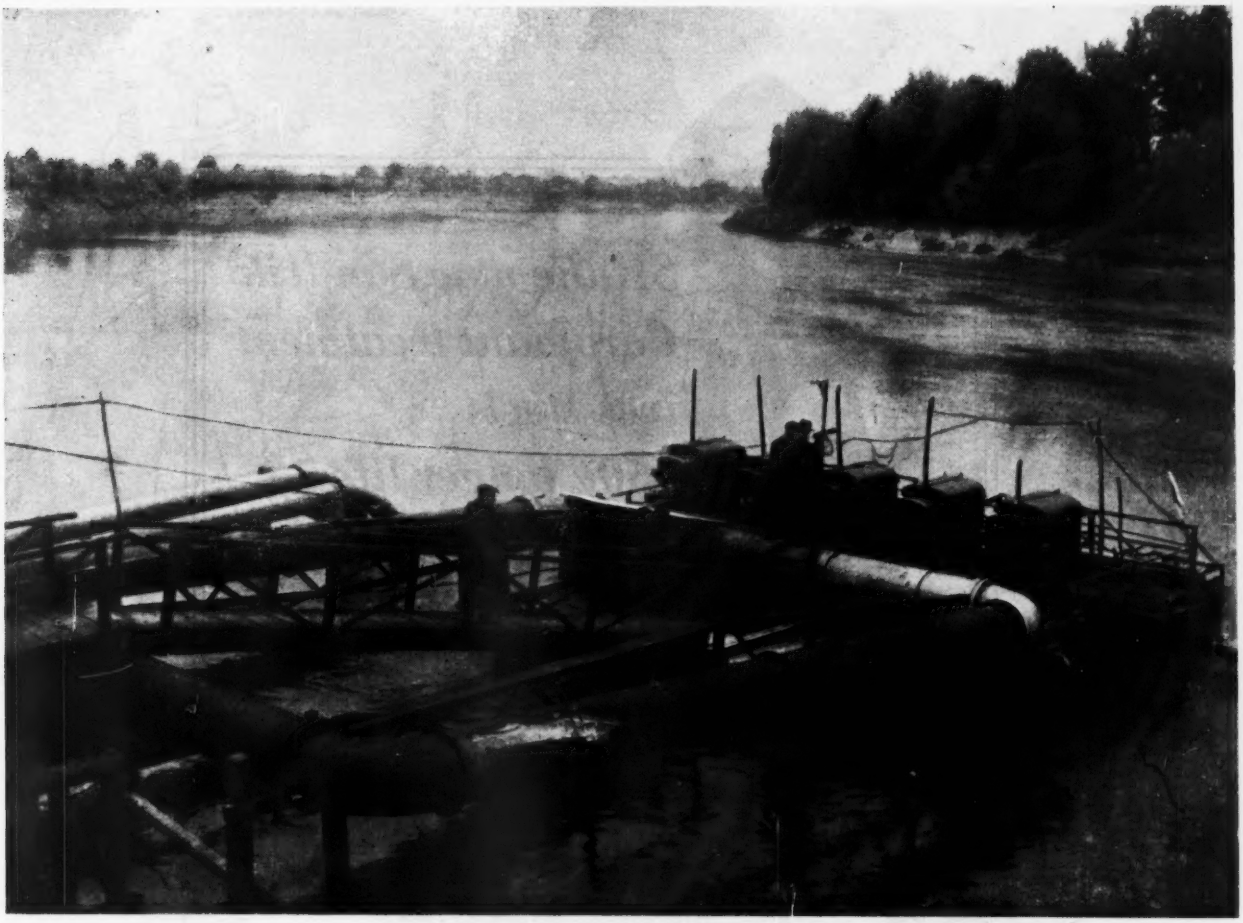

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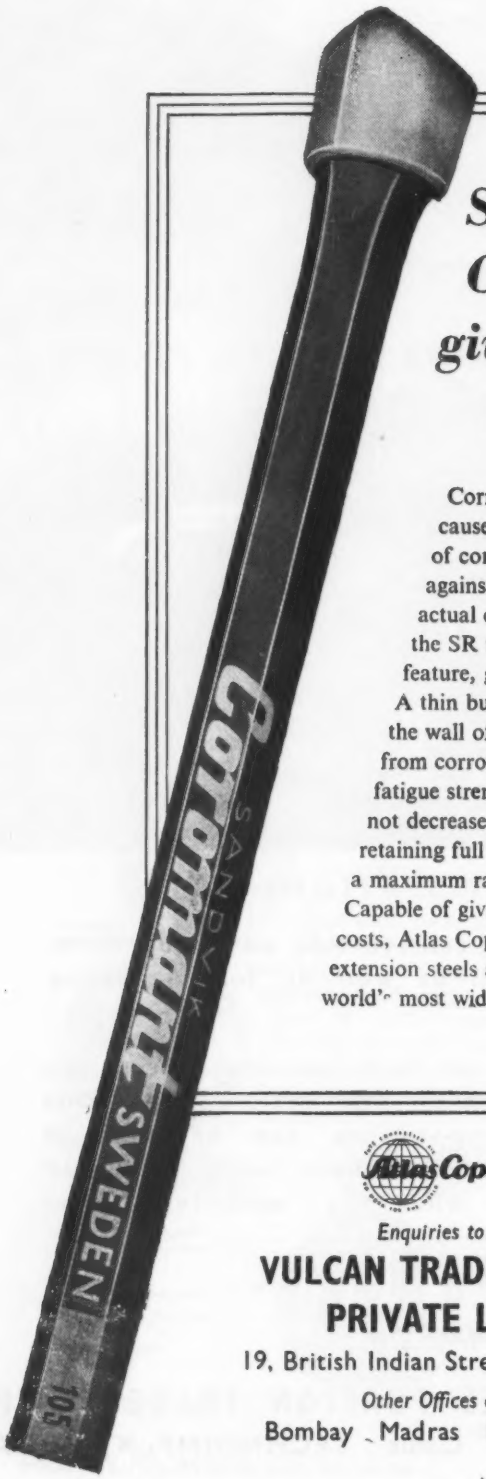

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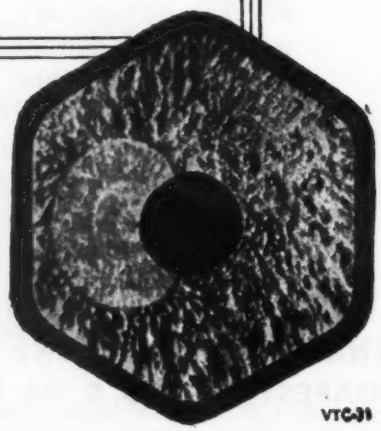

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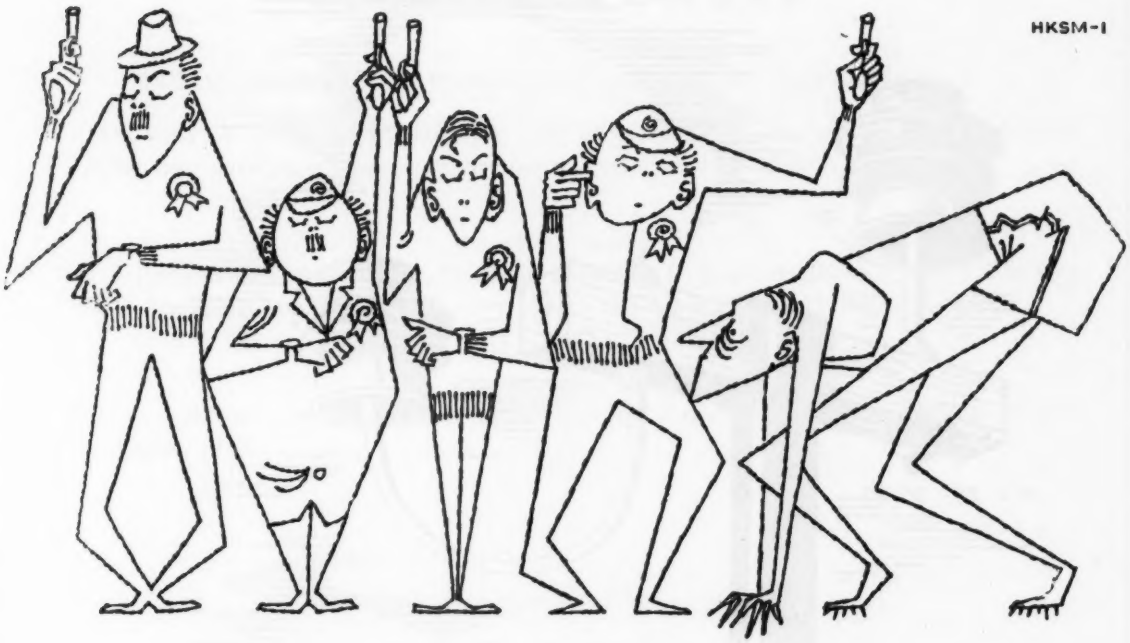

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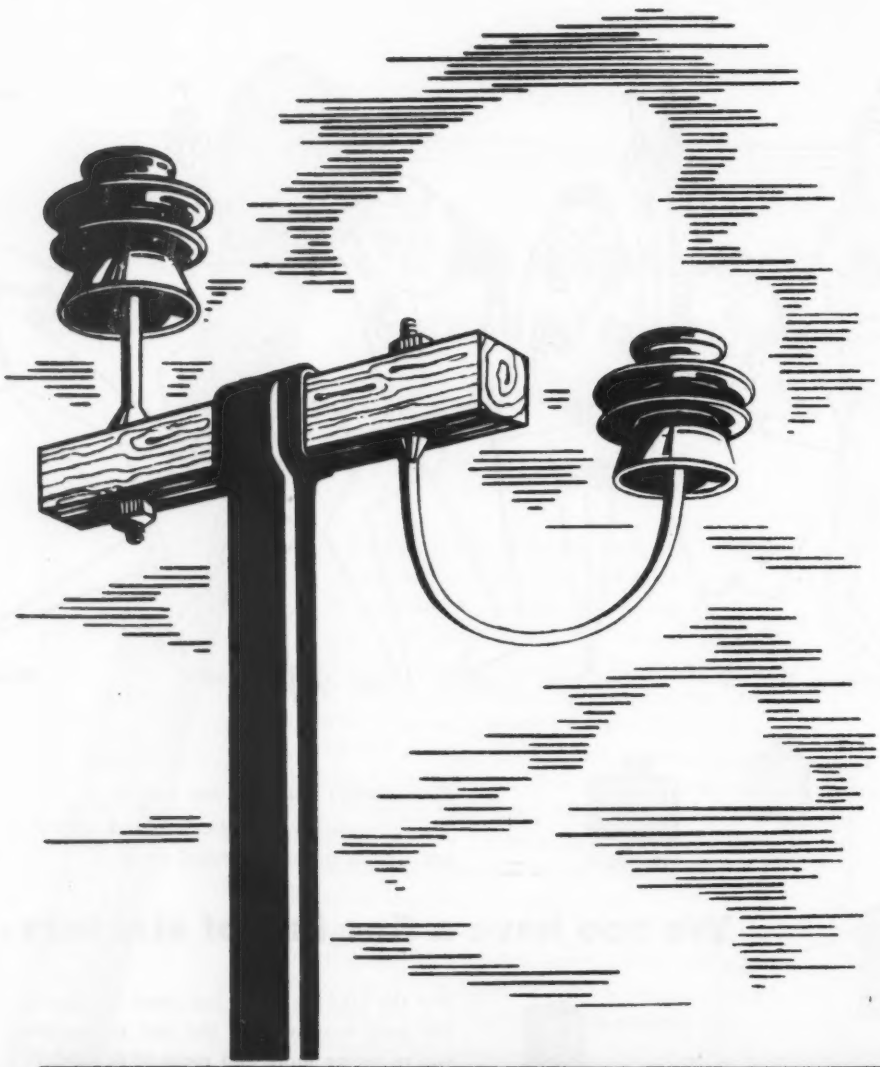

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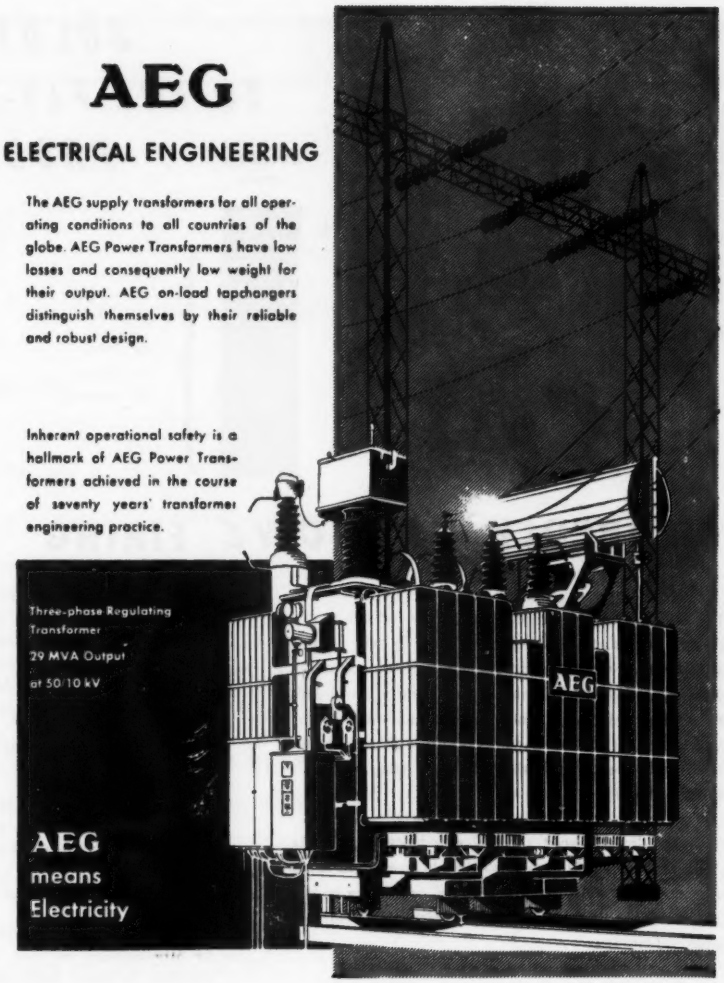

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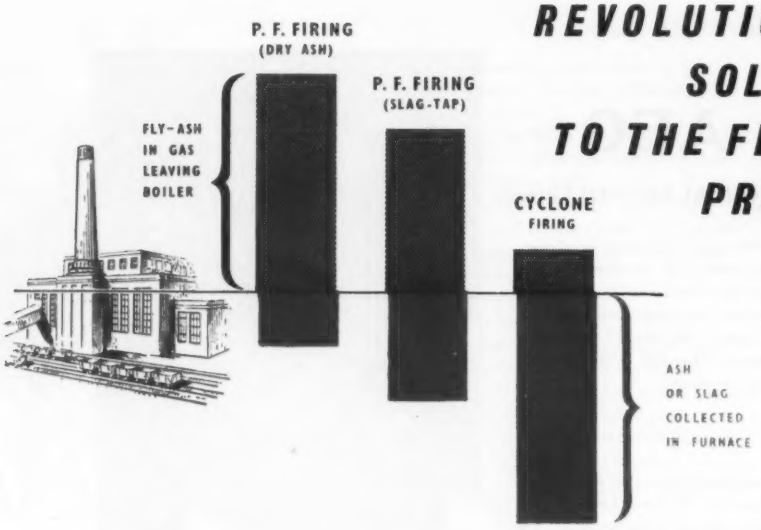

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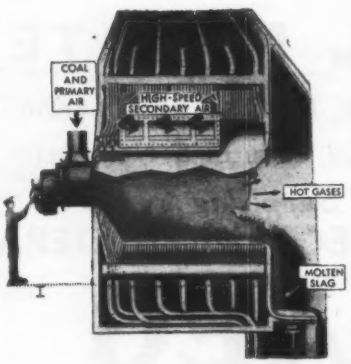

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ANDHRA PRADESH ELECTRICITY DEVELOPMENT NUMBER

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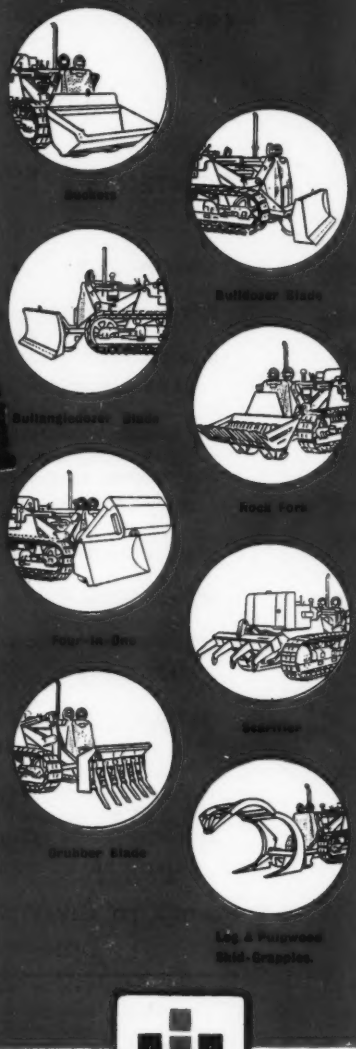

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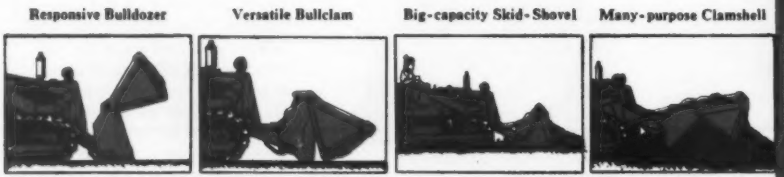

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Introduction

India is considered an under-developed region, compared to many western countries. Even so it is comparatively much more developed if we keep in mind the degree of development, or rather the lack of it, of many parts of Asia or Africa or even South America. But we have become so statistically or symbolically minded that we do not go behind the national averages and see how these are arrived at.

Take for example the figures for the per capita consumption of electricity. While the all-India average is 25, there is great deal of variation between the different regions. The figure for Andhra State is barely 8 while its adjacent state of Mysore is represented by 60. If electricity consumption is considered as an index of economic development of a region, then obviously Andhra has a considerable leeway to make up, inspite of the fact that it has more than doubled its capacity in the last five years.

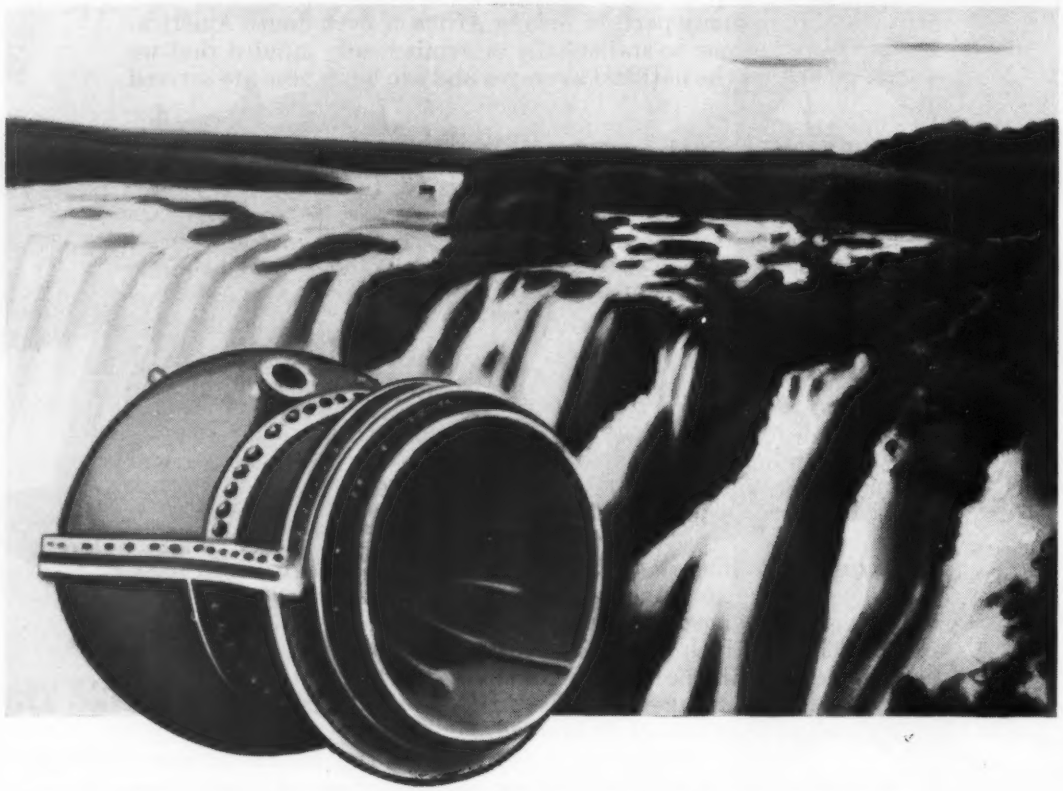
Andhra is rather a new State. It has immense resources for power, both hydro and thermal. In addition, it is rich in minerals like iron ore, limestone, graphite, gold, barytes, copper, silver, mica, ferromanganese. Its agriculture in some parts is rich. In other rather drier regions, with irrigation waters, the potentiality is great.

Above everything else its people are vigorous and virile. In short it has everything to make it as developed as almost any other part of India. What it needs most now is encouragement. Obviously those parts of India which are less developed due to historical reasons but which have all the natural resources for their potential growth need greater encouragement than before. Andhra has therefore certain claims that cannot be ignored.

In the field of electricity planning and execution, the State does not lack leadership. Indeed some of the works already accomplished and some others planned well ahead and in detail provide evidence that it has a farsighted and courageous leadership. If the State has to progress fast, it is important that this leadership is encouraged and made full use of.

The following contributions indicate in brief outline the nature of the potentialities for electricity, the various plans of development, the extent to which these have been accomplished and the role that electricity will play in the development of the State.

MACHKUND
HYDRO-ELECTRIC PROJECT



'English Electric' Cylindrical Balanced Valves have been specially chosen for use at the Machkund Power Station. Special advantages of these Valves are : close against any discharge—slam shutting impossible—low maintenance cost—require little space—operate quickly with absolute safety—readily accessible.

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Power Resources in Andhra Pradesh

By B. R. SOMAYAJULU

Andhra Pradesh is well served with abundant water supplies by the large rivers, Godavari, the Krishna and the Pennar with their several tributaries. The Tungabhadra River which is the chief tributory to the river Krishna also flows through Andhra Pradesh. The Western Ghats in the Penninsular India running as a continuous range along and close to the West Coast from where these rivers take their source recieve the most abundant supply of rainfall under the regular influence of the South West monsoon. However, all the country eastwards of the summits of the Ghats has to send the rain water to the Bay of Bengal as the Western Ghats are nowhere pierced by rivers. Thus the Godavari taking its source at Triambak in the Western Ghats near Nasik, only 50 miles to the east of the Arabian Sea, draining a catchment area of 1,16,300 sq miles lying in Bombay, Madhya Pradesh, Andhra Pradesh runs generally south-eastwards nearly 937 miles before falling into the Bay of Bengal. Similarly the Krishna taking its source at Mahabaleshwar in the Western Ghats, not far from the source of of the Godavari, runs over a distance of 775 miles on its way to the Bay draining a catchment area of 97,050 sq. miles lying in Mysore, Bombay and Andhra Pradesh. The above two rivers and the smaller Pennar having catchment of 20,000 sq. miles traverse Andhra Pradesh and hold almost all the potential hydro power resources of the State. However, as only the reaches of these rivers in the plains, (i. e. after the rivers have descended from the Western Ghats) lie in Andhra and the Eastern Ghats contribute only a small number of tributaries getting their supply from the undependable north-east monsoon, scope for high-head hydro projects is very limited. Most of the potential water power has therefore to be derived from irrigation-cum-hydro electric projects involving large dams and reservoirs. The interests of irrigation will also generally require that the waters from these reservoirs should be regulated to suit irrigation needs with the result that not all the hydro-electric power that can be produced from these reservoirs will be firm or in other words the generating capacity will not be uniform throughout all the seasons, being higher during irrigation discharge and lower during irrigation closure.

This leads to the question of firming up the difference in quantity of power that can be generated during the irrigation discharge and that during irrigation closure by installing thermal stations of adequate installed capacity. At present, there are three thermal steam stations in the Andhra area, one each at Visakhapatnam, Vijayawada and Nellore and one Station in Hyderabad and another at Ramagundam in Telengana area. The coal mines of Singareni will provide the requirements of fuel for thermal power production and other industrial purposes. These stations together with the 30 mW Nellore Thermal Station included in the Second Five Year Plan and the future super thermal station at Kothagudam may be made to work in coordination with large hydro electric stations and the seasonal power that may be available from the hydro electric stations firmed up. The power resources, some already in operation, some under construction and some under investigation, are detailed in the following paragraphs.

Power Station in Operation

Hydro Electric Stations

(*i*) *Machkund Hydro Electric Station*

The Machkund Hydro Electric Scheme is a joint venture of the Governments of Andhra Pradesh and Orissa, the capital cost and power benefits being shared in the ratio of 70: 30. Design, construction and operation of the station is the sole responsibility of Government of Andhra Pradesh according to the provisions of the Machkund Power Agreement between the states of Madras, now Andhra Pradesh and Orissa.

This station was the first hydro electric station to be commissiond in the State. It harnesses the waters of the Machkund river, a tributary of river Godavari, near the Duduma falls where a fall of 850 feet is available. The power site is situated about 125 miles by road from Visakhapatnam. The ultimate installed capacity is 114 mW.

The first stage development which is completed consists of the installation of 3 generators of 17000 kW each. The station was inaugurated in August, '55 by Rashtrapati. The station caters to the needs of Srikakulam, Visakhapatnam, East and West Godavari, Kistna, Guntur and Nellore districts.

(*ii*) *Nizamsagar Hydro Electric Station*

The Nizamsagar Hydro Electric Power Station

constitutes the first phase of power development on the Nanjira river, a tributary to Godavari. The station is situated below the intake works of Nizamsagar Reservoir. Three vertical type Kaplan turbines directly coupled to 5000 kW generators are installed.

The station is interconnected with the Hussainsagar Thermal Station. Power from the station varies from 3000 to 8000 kW depending upon the irrigation discharges.

(iii) Tungabhadra Hydro Electric Station

The Tungabhadra Hydro Electric Scheme comprises two stations, one at the Tungabhadra Dam and the other on the canal at Hampi. The ultimate installed capacity will be 36,000 kW at each station.

The first stage covers two units of 9,000 kW each at the Dam Power House, now in operation and three units of same capacity each at Hampi Power Station. The first unit at Hampi Power House was commissioned in February, '58. The Second unit is expected to go into operation, during March, '58. The third unit which is yet to be ordered may be commissioned before the end of the Second Five Year Plan period.

The Tungabhadra Hydro Electric Scheme is also a joint venture, the capital cost and power benefits being shared by Andhra Pradesh and Mysore in the ratio of 80:20.

The Tungabhadra Hydro Electric Stations serve the districts of Anantapur, Kurnool, Cuddapah and Chittoor.

THERMAL POWER STATION

(i) Hussainsagar Thermal Station

The Hussainsagar thermal station situated at Hyderabad, is the oldest thermal station in the State. The station caters mainly to the power needs of the twin cities of Hyderabad and Secunderabad. The aggregate installed capacity at the station, including the two diesel generating sets of about 1000 kW each, is 25,000 kW. The sets are old and the safe effective station capacity is only about 15,000 kW

(ii) Vijayawada Thermal Station

The Vijayawada Thermal Station with an installed capacity of 12,000 kW was the mainstay in the Andhra area until the Machkund Hydro Electric Station was commissioned in August, '55. This power station will serve as a standby to the Machkund Hydro Station.

(iii) Visakhapatnam Thermal Station

This station situated near the Visakhapatnam Harbour, has an installed generating capacity of 6,750 kW. With the advent of the Machkund Hydro Electric Station, the Visakhapatnam Thermal Station will act as a standby in the coastal districts in conjunction with the Vijayawada Thermal Station.

(iv) Nellore Thermal Station

The station was established in 1950 to afford supply of power mainly to the Nellore District. The station comprises two units of 2500 kW capacity each.

Ever since supply from Machkund Hydro Station was extended upto Nellore, the station was kept as a standby in this area.

(v) Ramagundam Thermal Station

The Ramagundam Thermal Station situated in the Karimnagar District of the Telengana area, was completed in the year 1957. Three units of 12,500 kW capacity each were commissioned. The scheme was originally conceived to cater to large industrial installations expected to come up in the vicinity of the station. Now that the load prospects in the vicinity of the station are found to be not as expected, arrangements are on hand made to utilize the power available at other load centres by constructing the necessary grid transmission lines and substations. This station will be shortly interconnected with thermal station at Hyderabad.

(vi) Diesel Stations

Before the grid network was established and before the major power stations like Machkund and Tungabhadra were commissioned, a number of pilot or nursery diesel stations were established in the erstwhile Andhra State area to stimulate load growth. The aggregate capacity of the diesel stations was about 15,000 kW. To most these places gird supply in now extended and these diesel stations have been shut down.

All the existing power stations, hydro and thermal feed into a state wide grid. The grid map of the Andhra Pradesh is appended.

Power Stations under construction

HYDRO ELECTRIC STATIONS

(i) Machkund Hydro Electric Station-II stage

The second stage of power development of the Machkund river comprises installation of three more units of 21,250 kW capacity each. Erection of the machines is in progress and is expected to be completed before the end of 1958-59.

(ii) Tungabhadra Hydro Electric Scheme-II stage

Under the second stage two units at Dam Power House and one more at Hampi all of 9000 kW capacity each are provided for. Work on the installation of two units at Dam Power House and one at Hampi is expected to be taken up and completed during the second Five Year Plan period.

(iii) Upper Sileru Hydro Electric Scheme.

The Upper Sileru Hydro Electric Scheme utilised the tail waters of Machkund Power Station at a place called Guntavada. Detailed investigation of the scheme had been completed and the scheme report is finalised.

Two 60,000 kW sets will be installed under the first stage and the estimated cost of head works and power station is only Rs. 6.0 crores.

This is a simple and economical project. It is the cheapest post—War hydro electric project in India, the cost per kW installed being only about Rs. 600. The first stage of this scheme is proposed to be taken up and completed during the second Five Year Plan period.

The ultimate installed capacity of the Upper Sileru Hydro Electric Power Station will be 300 mW.

THERMAL POWER STATION

(i) Nellore Thermal Station

The Tungabhadra project is an essentially irrigation

Facing page 2

STATEMENT No I

POWER POTENTIAL OF ANDHRA PRADESH

S.No.	Name of Power Stations	Installed capacity in kW	
		Present	*Ultimate*
	Existing (Hydro)		
1.	Machkund	51,000	1,14,750
2.	Nizamsagar	15,000	15,000
3.	Tungabhadra Dam	18,000	36,000
	Total..	84,000	1,65,750
	(Thermal)		
1.	Hyderabad	22,250	22,250
2.	Nellore	5,000	35,000
3.	Vijayawada	12,000	12,000
4.	Visakhapatnam	6,750	6,750
	Total..	46,000	76,000
	Under Consrtuction (Hydro)	**Initial**	**Ultimate**
1.	Hampi	18,000	36,000
2.	Upper Sileru	1,00,000	3,00,000
	Total..	1,18,000	3,36,000
	(Thermal)		
1.	Ramagundam	37,500	77,500
	Bulk Supply Purchase		
1.	Chittoor from Madras	3,400	
	Total..	3,400	
	Future (Hydro)		
1.	Devanur		42,000
2.	Lakshmipuram		3,10,000
3.	Lower Sileru		4,00,000
4.	Nagarjunasagar		3,00,000
5.	Pulichintala		20,000
6.	Ramapadasagar		1,72,000
7.	Siddeswaram		1,50,000
8.	Singareddi		1,45,000
9.	Sri Sailam		2,70,000
10.	Inchenpalli		5,00,000
	((Thermal)		
1.	Kothagudem (Pit head station)		90,000

constitutes the first phase of power development on the Nanjirs river, a tributary to Godavari. The station is situated below the intake works of Nizamsagar Reservoir. Three vertical type Kaplan turbines directly coupled to 5000 kW generators are installed.

The station is interconnected with the Hyderabad Thermal Station. Power from the station varies from 2000 to 8000 kW depending upon the irrigation discharges.

(iii) *Tungabhadra Hydro Electric Station*

The Tungabhadra Hydro Electric Scheme comprises two stations, one at the Tungabhadra Dam and the other on the canal at Hampi. The ultimate installed capacity will be 128,250 kW (4 units).

The first stage covers two units of 9,000 kW each at the Dam Power House now in operation and one unit of same capacity each at Hampi Power Station. The first unit at Hampi Power House was commissioned in February '58. The second unit is expected to go into operation during March '58. The fourth unit which is yet to be ordered may be commissioned before the end of the Second Five Year Plan period.

The Tungabhadra Hydro Electric Scheme is also a joint venture, the capital cost and power benefits being shared by Andhra Pradesh and Mysore in the ratio of 80:20.

The Tungabhadra Hydro Electric Stations serve the districts of Anantapur, Kurnool, Cuddapah and Chittoor.

THERMAL POWER STATIONS

(i) *Hussainsagar Thermal Station*

The Hussainsagar thermal station situated at Hyderabad, is the oldest thermal station in the State. The station caters mainly to the power needs of the twin cities of Hyderabad and Secunderabad. The aggregate installed capacity at the station, including the two diesel generating sets of about 1000 kW each, is 25,000 kW. The sets are old and the safe effective station capacity is only about 15,000 kW.

(ii) *Vijayawada Thermal Station*

The Vijayawada Thermal Station with an installed capacity of 12,000 kW was the mainstay in the Andhra area until the Machkund Hydro Electric Station was commissioned in August, '55. This power station will serve as a standby to the Machkund Hydro Station.

(iii) *Visakhapatnam Thermal Station*

This station situated near the Visakhapatnam Harbour, has an installed generating capacity of 6,750 kW. With the advent of the Machkund Hydro Electric Station, the Visakhapatnam Thermal Station will act as a standby in the coastal districts in conjunction with the Vijayawada Thermal Station.

(iv) *Nellore Thermal Station*

The station was established in 1950 to afford supply of power mainly to the Nellore District. The station comprises two units of 2,500 kW capacity each.

Ever since supply from Machkund Hydro Station was extended upto Nellore, the station was kept as a standby in this area.

(v) *Ramagundam Thermal Station*

The Ramagundam Thermal Station situated in the Telengana area, was completed in the year 1957. Three units of 12,500 kW capacity each were commissioned. The scheme was originally conceived to cater to large industrial installations expected to come up in the vicinity of the station. Now that prospects in the vicinity of the station are found to be not as expected, arrangements are on hand made to utilise the power available as other load centres by constructing the necessary grid transmission lines and substations. This station will be shortly interconnected with thermal station at Hyderabad.

(vi) *Diesel Stations*

Before the grid facilities were established and before the major power stations like Machkund and Tungabhadra were commissioned, a number of pilot nursery diesel stations were established in the erstwhile Andhra State area to stimulate load growth. The aggregate capacity of these stations was about 15,000 kW. To meet these phased grid supply is now extended and these diesel stations have been shut down.

All the existing power stations, hydro and thermal, are on a static basis. The grid map of the southern Pradesh is appended.

Power Stations under construction

(i) *Upper Sileru Hydro Electric Station-II stage*

The second stage of power development of the Machkund river comprises installation of three more units of 21,250 kW capacity each. Erection of the machines is in progress and reported to be completed by the end of 1958-59.

(ii) *Tungabhadra Hydro Electric Scheme-II stage*

Under the second stage two units at Dam Power House and one unit at Hampi all of 9000 kW capacity each are proposed for. Work on the installation of two units at Dam Power House and Hampi respectively is to be taken up and completed during the second Five Year Plan period.

(iii) *Upper Sileru Hydro Electric Scheme*

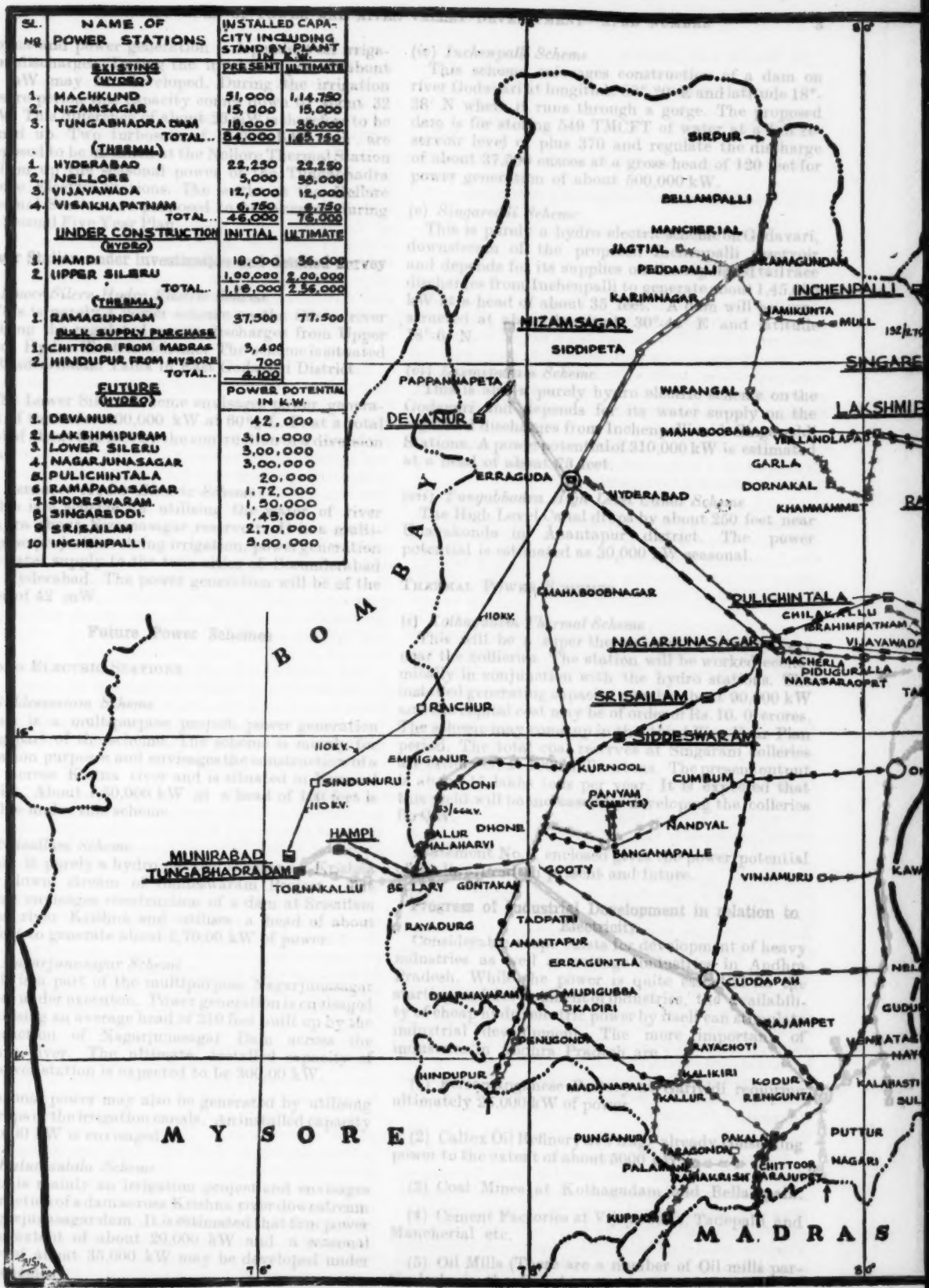
The Upper Sileru Hydro Electric Scheme utilises the tail waters of Machkund Power Station at a place called Donkarayi. Detailed investigations of this scheme has been completed and the scheme expert is finalised.

The ultimate installed capacity of the Upper Sileru Hydro Electric Power Station will be 300 MW.

THERMAL POWER STATION

(i) *Nellore Thermal Station*

The station is to meet an essentially irrigation


SL. NO
NAME OF POWER STATIONS
INSTALLED CAPACITY INCLUDING STAND BY PLANT IN K.W.
PRESENT
ULTIMATE
EXISTING (HYDRO)
1. MACHKUND 51,000 1,14,750
2. NIZAMSAGAR 15,000 15,000
3. TUNGABHADRA DAM 18,000 36,000
TOTAL.. 84,000 1,65,750
(THERMAL)
1. HYDERABAD 22,250 22,250
2. NELLORE 5,000 36,000
3. VIJAYAWADA 12,000 12,000
4. VISAKHAPATNAM 6,750 6,750
TOTAL.. 46,000 76,000
UNDER CONSTRUCTION (HYDRO)
INITIAL
ULTIMATE
1. HAMPI 18,000 36,000
2. UPPER SILERU 1,00,000 2,00,000
TOTAL.. 1,18,000 2,36,000
(THERMAL)
1. RAMAGUNDAM 37,500 77,500
BULK SUPPLY PURCHASE
1. CHITTOOR FROM MADRAS 5,400
2. HINDUPUR FROM MYSORE 700
TOTAL.. 6,100
FUTURE (HYDRO)
POWER POTENTIAL IN K.W.
1. DEVANUR 42,000
2. LAKSHMIPURAM 3,10,000
3. LOWER SILERU 3,00,000
4. NAGARJUNASAGAR 3,00,000
5. PULICHINTALA 20,000
6. RAMAPADASAGAR 1,72,000
7. SIDDESWARAM. 1,50,000
8. SINGAREDDI. 1,45,000
9. SRISAILAM 2,70,000
10. INCHENPALLI 9,00,000
BOMBAY
MYSORE
MADRAS
SIRPUR
BELLAMPALLI
MANCHERIAL
JAGTIAL
PEDDAPALLI
RAMAGUNDAM
INCHENPALLI
KARIMNAGAR
JAMIKUNTA
NIZAMSAGAR
SIDDIPETA
PAPPANAPETA
DEVANUR
WARANGAL
LAKSHMIP
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GARLA
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KHAMMAMME
ERRAGUDA
HYDERABAD
MAHABOOBNAGAR
PULICHINTALA
CHILAKALLU
NAGARJUNASAGAR
MACHERLA
PIDUGURALLA
NARASARAOPET
SRISAILAM
RAICHUR
SIDDESWARAM
110KV.
EMMIGANUR
KURNOOL
CUMBUM
SINDUNURU
ADONI
PANYAM (CEMENTS)
NANDYAL
HAMPI
ALUR
DHONE
HALAHARVI
SANGANAPALLE
MUNIRABAD
TUNGABHADRADAM
GOOTY
VINJAMURU
TORNAKALLU
BELLARY
GUNTAKAL
RAYADURG
TADPATRI
ANANTAPUR
ERRAGUNTLA
CUDDAPAH
DHARMAVARAM
MUDIGUBBA
KADIRI
RAJAMPET
PENUGONDA
RAYACHOTI
HINDUPUR
MALIKIRI
KODUR
MADANAPALLE
KALLUR
RENIGUNTA
PUNGANUR
PAKALA
PUTTUR
TADAGONDA
CHITTOOR
NAGARI
PALAMANER
KANAKRISHNARAJUPET
KUPPAM
KALAHASTI
75°
80°
16°
14°

SIRPU
BELLAMPA
MANCHERIA
JAGTIAL
PEDDAPALLI
KARIMNAGAR
NIZAMSAGAR
SIDDIPETA
PAPPANAPETA
DEVANUR
WARANGA
MAHABOOB
ERRAGUDA
HYDERABAD
MAHABOOBNAGAR
110KV.
NAGARJUNASA
SRISAILAM
RAICHUR
SIDDESWAR
110KV.
EMMIGANUR
KURNOOL
CUMBUM
SINDUNURU
ADONI
PANYAM (CEMENTS)
110KV.
33/66KV.
NANDYAL
HAMPI
ALUR DHONE
HALAHARVI
SANGANAPALLE
GOOTY
ORNAKALLU
BELLARY GOOTAKAL
TADPATRI
RAYADURG
ANANTAPUR
ERRAGUNTLA
DHARMAVARAM
MUDIGUBBA
KADIRI
PENUGONDA
HINDUPUR
MADANAPALLE
KALLUR
PUNGANUR
PALAMNER
KUPPAM
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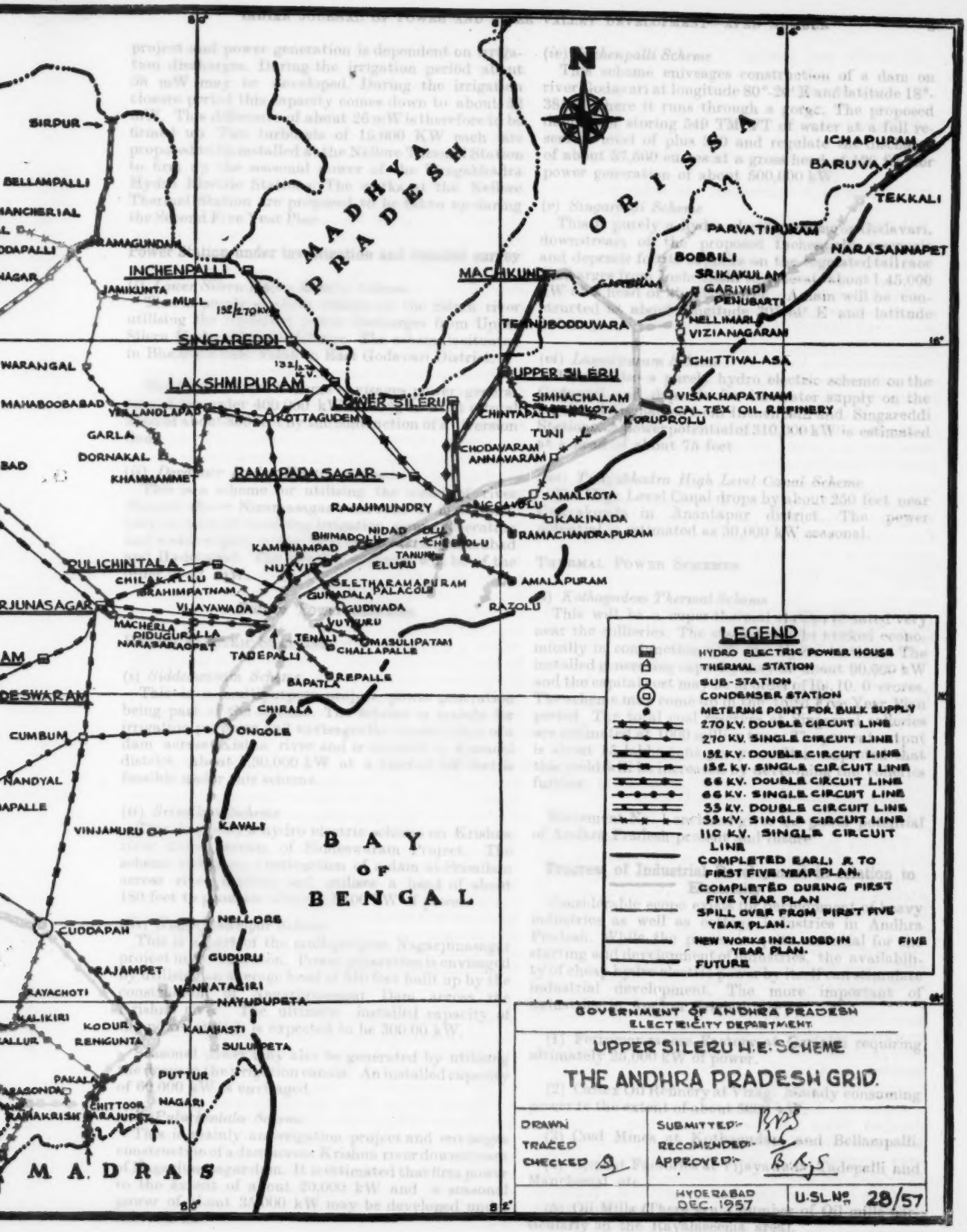

GOVERNMENT OF ANDHRA PRADESH
ELECTRICITY DEPARTMENT

UPPER SILERU H.E. SCHEME

THE ANDHRA PRADESH GRID.

DRAWN TRACED CHECKED	SUBMITTED:- RECOMENDED:- APPROVED:-	
	HYDERABAD DEC. 1957	U.S.L.No. 28/57

project and power generation is dependent on irrigation discharges. During the irrigation period about 58 mW may be developed. During the irrigation closure period this capacity comes down to about 32 mW. This difference of about 26 mW is therefore to be firmed up. Two turbosets of 15,000 KW each are proposed to be installed at the Nellore Thermal Station to firm up the seasonal power of the Tungabhadra Hydro Electric Stations. The works at the Nellore Thermal Station are proposed to be taken up during the Second Five Year Plan.

Power Station under investigation and detailed survey

(*i*) *Lower Sileru Hydro Electric Scheme*

This is purely a power scheme on the Sileru river utilising the regulated power discharges from Upper Sileru Hydro Electric Scheme. The scheme is situated in Bhadrachalam Taluk in East Godavari District.

The Lower Sileru Scheme envisages power generation of the order 400,000 kW at 60% L. F. at a total head of about 800 feet by the contruction of a diversion dam.

(*ii*) *Devanoor Hydro Electric Scheme*

This is a scheme for utilising the water of river Manjira above Nizamasagar reservoir. It is a multipurpose project involving irrigation, power generation and water supply to the twin cities of Secunderabad and Hyderabad. The power generation will be of the order of 42 mW.

Future Power Schemes

HYDRO ELECTRIC STATIONS

(*i*) *Siddeswaram Scheme*

This is a multipurpose project, power generation being part of the scheme. The scheme is mainly for irrigation purposes and envisages the construction of a dam across Kistna river and is situated in Kurnool district. About 1,50,000 kW at a head of 100 feet is feasible under this scheme.

(*ii*) *Srisailam Scheme*

This is purely a hydro electric scheme on Krishna river down stream of Siddeswaram Project. The scheme envisages construction of a dam at Srisailam across river Krishna and utilises a head of about 180 feet to generate about 2,70,00 kW of power.

(*iii*) *Nagarjunasagar Scheme*

This is a part of the multipurpose Nagarjunasagar project under executon. Power generation is envisaged by utilising an average head of 310 feet built up by the construction of Nagarjunasagar Dam across the Krishna river. The ultimate installed capacity of the power station is expected to be 300,00 kW.

Seasonal power may also be generated by utilising the drops in the irrigation canals. An installed capacity of 60,000 kW is envisaged.

(*iii*) *Puluchintala Scheme*

This is mainly an irrigation project and envisages construction of a dam across Krishna river downstream of Nagarjunasagar dam. It is estimated that firm power to the extent of about 20,000 kW and a seasonal power of about 35,000 kW may be developed under this scheme.

(*iv*) *Inchenpalli Scheme*

This scheme enivsages construction of a dam on river Godavari at longitude 80°-20′ E and latitude 18°-38′ N where it runs through a gorge. The proposed dam is for storing 549 TMCFT of water at a full reservoir level of plus 370 and regulate the discharge of about 37,500 cusces at a gross head of 120 feet for power generation of about 500,000 kW.

(*v*) *Singareddi Scheme*

This is purely a hydro electric scheme on Godavari, downstream of the proposed Inchenpalli reservoir and depends for its supplies on the regulated tail race discharges from Inchenpalli to generate about 1,45,000 kW at a head of about 35 feet. A dam will be constructed at about longitude 30°-44′ E and latitude 18°-6′ N.

(*vi*) *Laxmipuram Scheme*

This is also a purely hydro electric scheme on the Godavari and depends for its water supply on the regulated discharges from Inchenpalli and Singareddi Stations. A power potential of 310,000 kW is estimated at a head of about 75 feet.

(*vii*) *Tungabhadra High Level Canal Scheme*

The High Level Canal drops by about 250 feet near Unavakonda in Anantapur district. The power potential is estimated as 30,000 kW seasonal.

THERMAL POWER SCHEMES

(*i*) *Kothagudem Thermal Scheme*

This will be a super thermal station situated very near the collieries. The station will be worked economically in conjunction with the hydro stations. The installed generating capacity may be about 90,000 kW and the capital cost may be of order of Rs. 10. 0 crores. The scheme may come up in the third Five Year Plan period. The total coal reserves at Singarani colleries are estimated at 1000 million tons. The present output is about 15 lakhs tons per year. It is expected that this yield will be increased by developing the colleries further.

Statement No. 1 enclosed gives the power potential of Andhra Pradesh present and future.

Progress of Industrial Development in relation to Electricity

Considerable scope exists for development of heavy industries as well as cottage industries in Andhra Pradesh. While the power is quite essential for the starting and development of industries, the availability of cheap hydro electric power by itself can stimulate industrial development. The more important of industries in Andhra Pradesh are ;

(1) Ferromanganese Factory at Garividi requiring ultimately 25,000 kW of power.

(2) Caltex Oil Refinery at Vizag. already consuming power to the extent of about 5000 kW.

(3) Coal Mines at Kothagudam and Bellampalli.

(4) Cement Factories at Vijayawada, Tadepalli and Mancherial etc.

(5) Oil Mills (There are a number of Oil mills particularly in the Rayalaseema area).

(6) Textile and ginning.

(7) Sugar factories.

(8) Paint Industry.

(9) Tobacoo processing and manufacture of Cigarettes

(10) Jute Mills at Chittivalasa and Nellimarla.

(11) Paper (Rajamundry and Sirpur)

(12) Ship building.

With a first class harbour at Vizag and a number of minor ports at Kakinada, Masulipatam etc., with great rivers like the Godavari, the Krishna, the Pennar and the Tungabhadra and reasonable road and rail communications, Andhra Pradesh lends itself to judicious combination of road, rail, canal and coastal shipping transport which is essential for industrial development.

The Mica Mines at Gudur can be modernised and developed on a sound and economic lines when cheap power is extended to the area.

Other available minerals deposits of considerable economic value which can be exploited are : Iron Ore, Limestone, Graphite, gold, coal etc. In the Rayalaseema there are deposits of barytes, calcium, copper, zinc, gold, silver etc.

Large bulks of load have come up to the north of Ramagundam Power Station in Teleingana area. These are for Cement, Silk, Paper and Coal industries.

In spite of the immense mineral wealth in Andhra Pradesh the existing development has not been appreciable.

Demands for agricultural pumping is also growing rapidly. There is a large demand for power for small scale industries particularly in the rural areas.

Conclusion

The per capita consumption of electricity which is a recognised index of the economic development of any country is only about 8 units in Andhra Pradesh. This figure is very low compared with the all India figure of about 25 units and those of the neighbouring States of Madras and Mysore which are about 30 and 60 units respectively. Out of the total number of towns and villages viz., 26,000, only about 1,200 have so far been electrified. The above factors indicate the backwardness of the State in the matter of electrical development and the leeway that has yet to be covered.

Andhra Pradesh is one of the largest States in India. As stated already, it has considerable mineral resources. The State has reasonably good communications. Two large rivers, Krishna and Godavari flow through this State. With a population of 31. 26 millions and an area of 106 thousand sq. miles, the State possesses all the prerequisites for industrial and economic development. The reasons for this present beackwardness is mainly the lack of cheap electric power. This fact is emphasised by the load survey recently carried out and finalised by the Central Water and Power Commision which estimated a power shortage of over 60 mW in the Andhra Pradesh by 1960-61. The review of the power resources in Andhra Pradesh puts the power potential at about 3000 mWs of which only 6.5 per cent is so far developed.

It is therefore left to the State authorities concerned to develop the available abundance of natural resources and lead the State in the near future to the place it deserves amongst the progressive States of India.

Continued from page 9

Electricity Development in Andhra Pradesh.

prerequisites of industrial development are in plenty. It has considerable mineral resources.

Through the spread of cheap electricity into the rural areas for agriculture and small industries, and to urban areas for medium and heavy industries, Andhra Pradesh shall march ahead in the field of socio-economic development.

During the first Five Year Plan in the Andhra Area the capital expenditure, the length of the transmission lines constructed, the installed generating capacity have all been doubled. The revenue also has been doubled. Rural electrification was given special importance and the number of villages electrfied has been increased from 300 to 681 and thus more than doubled.

Under the State Re-organisaton Act 1956, the Hyderabad State has been divided into Telangana, Karnataka, and Marathwada regions. The Telangana area comprising nine districts was integrated with the erstwhile Andhra State to form a State of Andhra Pradesh on 1-11-1956. Coal reserves of Telangana are placed at over 1,000 million tons. The power development in Telangana area prior to commencement of the second Five Year Plan is more or less restricted to the Hyderabad and Secunderabad cities and development in the moffussil is practically nil.

Out of the 16,000 towns and villages in the Andhra area only about 1,000 towns and villages have been electrified so far. In the case of Telangana area, the present position is worse in as much as only 35 towns and villages were electrified out of the 10,000 villages and towns in the area. The per capita consumption in the Andhra Pradesh is only 8 at present.

Although considerable progress has been achieved during the first Five Year Plan period in the matter of electrical development, the above figure indicate the backwardness of Andhra Pradesh in the matter of rural electrification and necessity for broad-based power development programme to be launched in the near future. With the integration of the Telangana region with Andhra a co-ordinated programme of power development became essential. An integrated grid for Andhra Pradesh as a whole is evolved with a view to ensure a co-ordinated power development in the State. The map contains the Andhra Pradesh grid as now envisaged.

Electricity Development in Andhra Pradesh

The integrated development of Water and Land resources is vital for the economy of the country or State. Such programmes demand high priority. Electricity, especially, has a key role in the socio-economic uplift of any state. The per capita consumption of Electricity has thus come to be universally regarded as an index of the economic development of any State.

26th January 1958 marks the end of the first 10-year period since India became a Republic. The review of progress in retrospect in the sphere of electrical development is gratifying, considering the stage at the time of achieving independence. The same can be said of the State of Andhra Pradesh. The first Five Year Plan of Power Projects of Andhra Pradesh consisted of the first Five Year Plan of the former Andhra State as modified after the formation of Andhra State on 1-10-1953 providing for an outlay of Rs. 25.53 crores and the first Five Year Plan of the Telengana Area (of the former Hyderabad) providing for an outlay of Rs. 2.98 crores on Power Projects.

The per capita consumption of electricity, which is a recognised index of economic development of any country is only, about 8 units in the Andhra Pradesh. This figure is very low when compared with the all India figure of about 20 units. Andhra Pradesh is one of the largest States of India. It has considerable mineral resources. Two large rivers, Krishna andGodavari, flow through the State. The State has reasonably good communications. It can be seen therefore that all prerequisites for industrial and economic advancement exist in the State. The reason for its present backwardness is mainly lack of cheap electric power. This is emphasised by the load forecast of Andhra Pradesh, as finalised by the Central Water and Power Commission which has estimated a power shortage of about 70 mW in Andhra Pradesh by 1960-61. There is therefore vast scope for development and utilization of cheap hydro electric power in the area.

Achievements under the First Five Year Plan

ANDHRA AREA

The Andhra State was formed on 1-10-1953 (i.e.) in the middle of the first Plan period.

Progress during the first half of the Plan period in the Andhra State area of the composite State was slow. In the second half period in the new Andhra State the lee-way was made up. The Plan was fully implemented and targets fully realised and some exceeded.

Statement I shows the position at the beginning of the Plan period and progress achieved under the Plan.

Capital Expenditure

The capital expenditure during the first two years was of the order of Rs. 3½ crores per annum. During the second half, the scale of annual expenditure was nearly doubled. The shortfall in the initial years in the composite State was thus made up in the second half in the new Andhra State. The total expenditure has even slightly exceeded the Plan amount.

Machkund Hydro-Electric Scheme

This is the first hydro electric project so far undertaken in Andhra State. It is a joint venture of Andhra and Orissa Governments, the capital outlay and power being shared in the ratio of 70:30. The cost of the joint works is about Rs. 13½ crores. Transmission lines are the concern of individual States. The cost of the Andhra transmission scheme is about Rs. 10 crores. The ultimate capacity of the Machkund Station is 1,14,750 kW half of which is installed under the first Plan period. The project site is 130 miles away by road from Visakhapatnam, the road passing through difficult terrain. Labour had to be imported on large scale. Weather conditions restricted working period to 9 months in a year. Besides these natural difficulties, there was serious dislocation and delay in the supply of penstocks. By strengthening the road transport organisation, accelerating the construction programme and doubling the erection personnel and by working round the clock these difficulties were overcome and the commissioning of the first generator (17,000kW capacity) could be advanced by about one year. The scheme was inaugurated by Rashtrapati on 19-8-1955.

Tungabhadra Hydro-Electric Scheme

Tungabhadra Hydro Electric Project is also a joint venture. The capital cost and power benefits are to be ultimately shared by Andhra and Mysore in the ratio of 80:20. The common works comprise two generating stations, one at Tungabhadra Dam and the other on

the canal at Hampi, each with an ultimate capacity of 36,000 kW, of which 18,000 kW each is under installation. The cost of the joint works including the transmission line upto Bellary is about Rs. 7·2 crores. The execution of the common works is under the control of the Tungabhadra Board. The construction programme in the Tungabhadra Hydro Electric Project also is considerably accelerated and the first generating unit in the Dam Power House was commissioned in January 1957.

Installed Generating Capacity and Load:

Installed generating capacity at the beginning of the first Plan was only about 21,000 kW comprising 16,000 kW of steam and 5,000 kW of diesel generating sets. At the end of the Plan the installed capacity increased to 62,000 kW comprising 24,000 kW of hydro, 24,000 kW of steam and 14,000 kW of diesel generation. The aggregate load demand increased from 14,500 kW at the beginning to 32,000 kW at the end of the plan.

Revenue

By adopting a system of staggering and other restrictions and controls, the available resources of power were utilised for the maximum benefit. The revenue from electricity grew from Rs 40 lakhs at the beginning to about Rs. 168 lakhs at the end of the Plan.

The Andhra Grid

At the beginning of the plan there were in Andhra a few small scattered and isolated steam-and diesel stations with an aggregate mileage of about 2,900 of H. T and L. T. lines. About 2,900 miles of H.T. and L.T. Lines have since been added, thus doubling the aggregate length. There is now a grid in Andhra covering the whole length from the Orissa border in the north to the Mysore border in the west. The grid is operating at 132 kV upto Vijayawada and at 66 kV thereafter. This is enabling the hydro and thermal stations to be operated in a co-ordinated manner insuring overall economy. It can now be said that any consumer in Andhra small or big, situated anywhere, will get the supply he requires in the time he can get himself ready.

Tariffs

There was a multiplicity of the tariffs in different regions in Andhra. This was due to different tariffs applicable to different steam and diesel thermal stations, acquired licensee areas, and areas where purchased bulk power was distributed. The tariffs were rationalised and simplified in number and made applicable throughout the State. This is calculated to spread the burden on consumers evenly and make for rapid development of agriculture and industry all over the State.

Rural Electrification

Rural electrification has a special significance to our country and particularly to Andhra. Electricity is not a mere amenity but a modern economic tool. It must be made available to all our villages to improve rural economy and ensure balanced development and to prevent concentration in urban areas. Only 200 towns and villages were electrified in Andhra in the 12-year period preceding the first Plan. By extending the grid lines into rural areas, by installing small pilot diesel stations in the remote areas and by adopting all economies, by manufacturing rural line materials, special efforts are made in the matter of rural electrification. About 476 additional towns and villages electrified during the Plan period, bringing the total to about 681. The number of agricultural pump sets and rural industries increased from 620 and 350 at the beginning of the Plan to 4300 and 3800 respectively at the end of the Plan period.

Acquisition of Licensee's Undertakings

Rural Electrification is as a rule generally expensive and unremunerative. It is to be pursued only on grounds of national policy by subsidising in one form or another. Licensees who are profit-minded cannot be expected to give any special attention to rural electrification. Furthermore certain licensees were inefficient and unprogressive. A policy of nationalisation of licensee undertakings was therefore adopted and necessary legislation enacted.

Acquisition of licensee undertakings has been taken in hand.

Per Capita Consumption

The per capita consumption of electricity in Andhra at the beginning of the first Plan was 2.5 units. This increased to nearly 8 at the end of the first Plan period.

TELANGANA AREA

Nizamsagar Hydro-Electric Project

The Nizamsagar Hydro-Electric Power Station constitutes the first phase of power development on the Manjira river, a tributary of the river Godavari, in Hyderabad State.

The Nizamsagar Reservoir which was completed in 1929 has a storage capacity of 29,700 m. Cft. Utilising the head available due to the drops and the variable head in the dam, a power station has been coustructed below the head sluice. The total head varies from 65′ to 35′.

Three vertical type Kaplan Turbines directly coupled to 5000 kW generators are installed. Power is transmitted to Hyderabad by a double circuit 66 kV transmission line, about 64 miles in length.

The power station is interconnected with Hussainsagar Thermal Station, at Erragudda sub-station. The power house was completed in the Plan period, and power is being delivered to Hyderabad.

Ramagundam Thermal Scheme

The Ramagundam Thermal Power Scheme was originally started under the Godavari Valley Development schemes. Among the various schemes, under the Godavari Valley, it was decided to first instal a power station at Ramagundam on Kazipet-Balharshah line of the Central Railway.

Work was taken up on the power station designed to have an installed capacity of 37,500 kW. A major portion of the work has been carried out during the first Five Year Plan period.

By the end of the first Five Year Plan period the boiler plant and the 3 turbo-alternators were fully erected. The switchgear is mostly installed. The cooling tower is almost complete except the Central feed. The pumping scheme for pumping water from

Godavari to the power station is also nearly completed. The boilers were ready for tests.

The Power generated will be distributed over an area of 4000 sq. miles covering nearly five districts and twelve taluqs. Work is on hand for the construction of nine major sub-stations on the 66,000 volts line.

Important industries like cement and coal will be taking power from this power station. In order to make the people electricity conscious and to build up load, five nursery power stations have been started and power is being supplied from diesel generating sets at Mancherial, Azamabad, Peddapalli, Karimnagar and Mulug. The return will not only be in the shape of sale of electricity but also in the shape of increased employment, better living conditions and increased agricultural production.

The transmission and distribution systems consist of :

(*i*) One 125 miles double circuit 66 kV line running from Ramagundam to Hyderabad, supplying power on the way at Peddapalli, Karimnagar and Siddipet.

(*ii*) One single circuit 66 kV line running from Ramagundam via. Peddapalli and Jamikunta to Hanumakonda.

(*iii*) One double circuit 66 kV line running from Ramagundam to Mancherial with provision for extension upto Sirpur-Kagaznagar.

(*iv*) A number of sub-transmission and distribution lines and sub-stations.

The progress to the end of the first Five Year Plan period was that the distribution lines at 5 centres and nearly 66 miles of Tower line have been completed with a number of sub-transmission lines also. The progress was handicapped due to necessary materials given under the Colombo Plan Aid having been delayed considerably and due to difficulty in getting materials like steel supports for the distribution lines.

Rural Electrification

An amount of Rs. 47.5 lakhs was given as a loan to composite Hyderabad State Government by the Central Government for the year 1955-56 for the electrification of 17 towns and villages under the scheme of expansion of power facilities. To improve employment opportunities of this department amount Rs. 27 lakhs was apportioned to Telengana area. Due to long delivery period for line materials and generating plant no expenditure was incurred. The expenditure upto end of March, 1956, was negligible. Thus an amount of about Rs. 27·0 lakhs spilled over into second Five Year Plan.

Second Five Year Plan Power Project

ANDHRA AREA

The second Five Year Plan power projects for Andhra area envisage an outlay of Rs. 21. 66 crores. (vide Statement II).

It Provides for

(*i*) Installation of the balance 3 (21,250 kW capacity) generating sets at Machkund.

(*ii*) installation of the balance 4 (9,000 kW) generating sets at Tungabhadra—two at the Dam and two at the Hampi Power Houses.

(*iii*) installation of a 30,000 kW thermal station at Nellore to firm up the seasonal power at Tungabhadra and stabilize the grid supply ;

(*iv*) electrification of additional 820 villages, and

(*v*) preliminary work on the Upper Sileru Hydro Electric Scheme under a small provision of Rs.50 lakhs.

There Works will :

(*a*) bring into operation additional installed generating capacity of 130,000 kW ;

(*b*) increase the peak load by 80,000 kW bringing it up to 118,000 kW ; and

(*c*) increase the revenue by Rs. 1.47 crores, bringing it up to Rs. 4.0 crores per annum.

The per capita consumption will increase from 8 to 20 units. These and other targets are shown in Statement III.

TELANGANA AREA

(i) *Ramagundam Thermal Power Shceme*

A sum of Rs. 13.05 lakhs has been provided in the second Five Year Plan for the completion of the Ramagundam Thermal Power Station.

It is proposed to increase the steam generating capacity of the station by the addition of one boiler 150,000 lbs. per hour capacity aud a cooling tower. A sum of Rs. 38.20 lakhs has been provided for this scheme in the second Five Year Plan.

In order to cater the needs of the large industrial concerns coming up in the Mancherial Bellampalli regions, it is proposed to erect a 66 kV double circuit transmission line from Ramagundam. A sum of Rs. 19.20 lakhs has been provided for the purpose in the second Plan.

(ii) *Nizamsagar Hydro-Electric Schemes*

A sum of Rs. 17.10 lakhs has been provided in the second Five Year Plan for the completion of this scheme.

(iii) *Devanoor Hydro Electric Project*:—

In the first stage only the construction of a dam across the river Manjira at Devanoor is proposed. The construction of a dam at Devanoor provides a continuous discharge of 12,000 cusecs into Manjira river and thereby raises the firm capacity of the Nizamsagar Station, from 2000-3000 kW to 8000-10,000 kW. A sum of Rs. 220 lakhs has been provided for this scheme during the second Five Year Plan.

(*iv*) *Re-organisation of Hyderabad & Secunderabad City Electricity network*

With the proposed interconnection of Ramagundam Thermal Station and the Nizamsagar Hydro Station with Hyderabad, it is essential to re-organise the city distribution system. Arrangements have to be made to erect the distribution sub-stations and lay a ring-main to distribute the additional power in the city.

For this work an amount of Rs. 85.50 lakhs has been provided in the second Five Year Plan. The system includes establishment of key sub-stations, 33 kV ringmains, remodelling of city distribution system to 6.6 kV and a provision for an additional boiler and switchgear at Hussainsagar power station.

(*v*) *Rural Electrification Scheme*

The Scheme provides for the installation of small and medium size diesel power stations and extentions from the existing power stations at various towns and villages in different parts of the Telangana region where at present there is hardly any electrification. The scheme envisages electrification of 37 towns and villages at a cost of Rs. 70.9 lakhs under the second Five Year Plan. However by a readjustment between the plan amounts for the different schemes it is now programmed to electrify about 207 towns and villages in the second Five Year Plan period.

(*iv*) *Investigation of Projects*

A sum of Rs. 3.80 lakhs has been provided in the second Five Year Plan for the investigation and survey of hydro electric projects in the Godavary Valley Basin.

Progress during the year 1956-57 and Programme for the years 57-58 and 58-59.

ANDHRA AREA

Machkund Hydro-Electric Scheme

During the year 1956-57 the third generating unit of 17,000 kW capacity relating to the first stage was commissioned in June'56. Orders for the Second Stage machinery (4th, 5th machines under the spill-over scheme and 6th machine under the new scheme each of 21,250 kW capacity) were placed and civil works associated with their installation taken up. The Jalaput Dam is 70% completed by the end of the year 1956-57. During the year 1957-1958 and 58-59 Jalaput Dam and other civil works will be completed. The machines will be received during the year 1957-58 and will be erected during the years 1957-58 and 58-59. All the three machines will be commissioned before the end of the year 1958-59.

Tungabhadra Hydro-Electric Scheme

The first generating set of 9,000 kW capacity at the Dam Power House was commissioned in January 1957. The second unit was commissioned in May 1957. Tne Hampi Power House building has been completed in 1956-57. The other works like the formation of the forebay, erection of penstocks and erection of balance machinery was in progress. Before the end of the year 1957-58, the first and second generating units 9,000 kW capacity each are expected to be commissioned in Hampi Power House. Orders for the balance generating machinery will be placed during the year 1957-58 and work connected with the installation of these machines is expected to be taken up in the year 1958-59.

Sileru Hydro-Electric Scheme

Machkund river in its lower reaches is called 'Sileru'. Hydro-electric generation is possible at two sites on the river where the river drops down by about 400′ and 650′ respectively. The ultimate power potential at both the sites is over 600 mW. Development of Upper Sileru will be first taken up.

Only a small provision is made for the scheme in the Second Five Year Plan towards detailed investigations and preliminary works. Aerial survey and detailed investigations have been completed.

The scheme has been properly investigated and recently finalised in consultation with the Central Water and Power Commission.

The Upper Sileru Hydro Electric Project—first stage is unique in Andhra Pradesh combining in itself several advantageous features such as economy, simplicity, high remunerative character, utilisation of existing released resources of construction machinery, experienced personnel and organisation and minimum foreign exchange. The Upper Sileru Hydro Electric Project—first stage is a vital and urgent necessity for Andhra Pradesh, 120/100 mW of installed generating capacity can be achieved for a capital investment of only Rs. 6 crores which works out to about Rs. 600 for a kW of firm power. The post-war projects in India are costing from Rs. 1000 to over Rs. 2,000 for kW installed.

Rural Electrification

In view of the special significance of rural electrification in the State, special efforts are being made in this direction. 240 villages have been electrified during the year 1956-57. The programme for 57-58 and 58-59 is to electrify another 200 villages in each year. Electricity supply will be extended to the following bulk loads :

(*i*) Caltex Oil Refinary at Visakhapatnam 5000 kW
(*ii*) Ferro Manganese Factory at Garividi 25,000 kW
(*iii*) Andhra Cement Co., Vijayawada additional load. 1000 kW
(*iv*) Krishna Cement Co., Additional load 3000 kW
(*v*) Nagarjunasagar construction works 3000 to 5000 kW
(*vi*) Macherla Cement Factory 3000 kW

Part supply to most of these loads has already been effected during the year 1956-57 and the full demand is expected to materialise during the year 1957-58.

Investigation of new Power Projects

Investigation of the lower Sileru Hydro-Electric Scheme was under progress during the year 1956-57. Investigation on this scheme will be continued and besides this, investigation in respect of Nagarjunasagar hydro-electric scheme and Srisilem hydro-electric scheme will be taken up during the years 1957-58 and 1958-59.

TELANGANA AREA

Ramagundam Thermal Power Scheme

During the year 1956-57 three out of 6 boilers, one out of three alternators and the cooling tower were tested satisfactorily. Erection of 66 kV Ramagundam-Mancharial and Peddapalli-Hanumakonda transmission lines was under progress.

During the year 1957-58 it is programmed to com-

STATEMENT. I.

Andhra Pradesh State First Five Year Plan Power Projects

Achievements

S. No.	Particulars	Unit.	As at the commencement of First Plan i.e. as on 1-4-51		As at the end of First Plan i.e. as on 31-3-1956.	
			Andhra area.	Telangana area.	Andhra area.	Telangana area.
1.	Installed generating capacity.	kW.	21,400	21,700	62,200	36,700
2.	Capital expenditure incurred.	Rs. in crores.	5.83	..	31.53	
3.	Aggregate peak demand.	kW.	12,600	10,000	38,000	16,600
4.	Consumers served.	Nos.	10,300	20,000	1,08,000	41,000
5.	Agricultural services.	Nos.	620	..	3,680	..
6.	Villages and towns electrified.	Nos.	205	7	681	16
7.	Gross revenue for annas.	Rupees (crores.)	0.400	..	1.68	0.8
8.	For capita consumption.	Units.	2.5	..	8	3.6

STATEMENT. II(*a*)

Andhra Pradesh State Power Projects

II Five Year Plan—Expenditure—Andhra area

Sl. No.	Name of Scheme	Second Plan Total on	Expenditure in May 1956-57.	Expenditure in 57-58 R.E. Provision	Proposal for 1958-59
1	2	3	4	5	6
	SPILL OVER SCHEMES :			Rs. in lakhs.	
1.	Machkund Hydro-Electric Scheme.	254.0	210.0	70.0	35.58
2.	Tungabhadra Hydro-Electric Scheme.	383.0	213.0	141.26	40.00
	NEW SCHEMES :				
3.	Machkund Hydro-Electric Scheme Second Stage	180.0	28.0	51.65	100.00
4.	Tungabhadra Nellore Hydro-Thermal Scheme	675.0	71.0	71.58	139.92
5.	Upper Sileru Hydro-Electric Scheme.	50.0	10.0	7.35	20.00
6.	Rural Electrification including extensions costing over Rs. 10 lakhs & extension of supply to bulk loads in Andhra area	614.27	322.0	176.16	160.00
7.	Investigation of New-Projects.	10.00	6.0	2.0	2.0
		2166.27	860.0	520.0	497.50

STATEMENT. II (*b*)

Andhra Pradesh State Power Projects

II Five Year Plan Expenditure Telangana Area

Sl. No.	Name of Scheme	Second Plan outlay	Expenditure in 1956-57	Expenditure in 1957-58 Rd. Provision	Proposal for 1958-59
	SPILL OVER SCHEMES.				
1.	Ramagundam Thermal Scheme.	194.45	64.43	104.35	21.6
2.	Nizamsagar Hydro-Electric Project.	217.10	3.97	13.20	0.4
	NEW SCHEMES.				
3.	Devenoor Hydro Electric Project.	220.00	..	1.00	..
4.	Reorganisation of City Circle.	85.50	25.00	5.000	22.50
5.	Ramagundam Thermal Station.	INCLUDED IN ITEM (I) ABOVE.			
6.	Northern Feeder (66kV) Ramagundem.				
7.	Rural Electrification Scheme.	70.0	20.10	40.000	10.62
8.	Investigation of Projects (Godavari Basin)	3.80	0.06	1.15	1.00
	Total..	591.75	113.56	164.70	56.12

STATEMENT III (*a*)

Andhra Pradesh State—Second Five Year Plan

Power Projects—Targets—Andhra Area

Sl. No.	Particulars.	Unit	At the commencement of 2nd five year plan i.e. as on 31-3-1956.	TARGETS 1956-57 for year	57-58	58-59	59-61	Total for the plan	At the end of the plan as on 31-3-61
1	2	3	4	5	6	7	8	9	10
1.	Installed capacity	kW	62,200	19,100	21600	44600	58800	144100	206,300
2.	Aggregate Peak Demand	kW	38,000	6400	30000	18000	26000	80400	118,400
3.	Consumers served	Nos	1,08,000	15360	16000	18000	40640	90000	1,98,000
4.	Agricultural services	Nos.	3680	765	1000	1000	2555	5320	9,000
5.	Villages and Towns electrified	Nos.	681	220	200	200	200	820	1501
6.	Gross revenue per annum	Crores.	1.68	2.08	2.58	3.38	4.00	..	4.00
7.	Per capita consumption	kWh. Units	8	2	2	2.5	5.5	12	20

STATEMENT III (*b*)

Andhra Pradesh State—Second Five Year Plan

Power Projects—Targets—Telangana area

Sl. No.	Particulars.	Unit	At the commencement of 2nd Five year plan i.e. as on 31-3-1956.	TARGETS for 56-57	57-58	58-59	59-61	Total for the plan period	At the end of the plan as on 31-3-61
1.	Installed capacity.	kW	36700	..	37500	3000	1000	41500	78200
2.	Aggregate peak demand	kW.	16600	100	9400	7500	1200	29000	46500
3.	Consumers served	Nos	41000	8000	10000	10000	24000	52000	93000
4.	Villages and Towns electrified.	Nos.	9	7	50	50	100	207	216
5.	Gross revenue per annum	lakhs	80.13	80.13	100.0	150.0	200.0	..	200.0
6.	Per capita Consumption	kWh units	5.6	..	1.4	1	2	4.4	10

plete the northern feeder upto Sirpur and arrange to supply the following bulk loads :

Sirpur Paper & Silk Mills	4,600/6000 kW
Bellampalli Collieries	4,000 kW
Mancharial Cement Factory	3,000/6000 kW
Ajamjahi Mills, Warrangal	2,000 kW

The original design of the station was based upon the idea of distributing large amount of power at 11kV. locally for some industries. The amount of step-up transformer capacity for transmission at 66 kV was therefore limited to less than half of the station capacity. The position is now different and there is no prospect of bulk loads near the power house for being supplied directly at 11 kV.

A comprehensive scheme, "Telangana Hydro-Thermal Scheme", has been finalised by the department during the year 1957-58 including necessary additions to Ramagundam Thermal Station and also covering net-work of transmission lines and sub-stations for the entire Telangana area with the existing Nizamsagar Hydro-Electric Scheme and Hussainsagar Power House with distributions at Secunderabad and Hyderabad.

Nizamsagar Hydro-Electric Project :

Electric of transmission line between the Nizamsagar Power House and Yerraguda Sub-station near Hyderabad was completed and a temporary relief of about 3,600 kW is being obtained from the Nizamsagar Hydro-Electric Power House for utilisation at Hyderabad. In order to avail the full seasonal power from Nizamsagar power Station it is programmed to increase the capacity of the tie line between Yarraguda sub-station and Hussainsagar Power Station in the year 1957-58.

Rural Electrification Scheme

Seven towns have been electrified during the year 1956-57. It is programmed to electrify about 50 villages during each of the years 1957-58 and 1958-59. For achieving this object the existing organisation has to be considerably strengthened and special efforts are being made to achieve the targets. It is programmed to install pilot diesel generating stations for supply to remote villages during the years 1957-58 and 1958-59. These stations are of portable character and will be shifted from place to place as and when grid supply is extended to each pilot diesel centre.

Re-organisation of City Electricity Supply net work

The conversion of 3.3 kV main to 6.6 kV main in some places of the city was completed. During the years 1957-58 and 1958-59 the work connected with the erection of 33 kV ring main and also laying radial and ring main feeders in the city will be taken up for execution.

Devanur Hydro Electric Project

The Scheme is yet to be investigated in detail ; Preliminary investigation is now on hand.

Difficulties confronted and overcome

The large transmission line constructon programme required considerable number of additional experienced field staff and put a strain on the departmental organisation. In order to meet the requirements of line staff two technical training schools for line men, wire men etc. were started, one at Anantapur and another at Vijayawada. Further, part of the transmission and distribution work had to be executed by entrusting the work to experienced contractors. This procedure which is new to the Department required formulation of special specifications, contract forms etc.

Rapid extension of the department consequent on the large capital expenditure programmes resulted in the rapid promotions of relatively junior engineering staff. To offset resultant dilution of the technical efficiency, a system of training departmental engineers in large numbers was introduced. The international technical training schemes under the Colombo Plan, Point Four programme, U.N. fellowship schemes etc., were fully utilised. In addition to these, arrangements were made under the various machinery supply and erection contracts for training departmental engineers at manufacturer's works and utilising them in the erection works here as part of the contractors' erection personnel.

Extra high tension lines 66 kV and above usually take three years or more to be completed under the routine method of calling tenders and letting out on contract. In order to expedite construction for such lines and keep up to the schedule of extension of suppy to various consumers, the department procured the necessary joist and steel sections and evolved suitable designs for transmission line supports with the available steel. These transmission line supports were fabricated in the departmental workshops. By these arrangements the lines could be constructed within one year as against three years under the contract system. It was also necessary to strengthen the transport and stores organisation suitably in the department.

To keep pace with the payments due to contractors and suppliers on accelerated construction programme, regional pay offices have been set up. This has facilitated prompt payments and obviated delays in construction programmes incidental to delayed payments.

Similarly to facilitate efficient assessment, billing and collection of revenue from consumers and to cope up with the growing revenue, regional revenue offices were set up.

During the Second Five Year Plan period the programmes were upset on account of the critical position and shortage of foreign exchange. It is however hoped that there will be no shortfall in the matter of expenditure, as it is possible to utilise the savings, resulting in deferred payment system now insisted by the Government of India, on other extensions of electric supply and rural electrification involving no foreign exchange.

Conclusion

Extension of electricity is basic to the development of the State and constitutes the foundation of future progress particularly in the industrial field. Rural electrification is particularly important and must be fully assisted.

Andhra Pradesh is a large State with 30 million population, with great rivers like Godavari and Krishna. It has over 15% of potential water resources, the hydro-electric power potential of Andhra Pradesh is estimated at over 1½ million kW. The essential

Continued on page 4

Machkund Hydro-Electric Project

The Machkund powerhouse is situated in the Koraput district of Orissa State, 120 miles by road from Visakhapatnam via Ananthagiri Ghats, Araku valley in Andhra and Padwa in Orissa. It is also accessible by road from Bobbili via Salur in Andhra and Koraput and Jeypore in Orissa, a distance of again 120 miles.

Project and its genesis

The "Duduma Falls" with a drop of 550 ft. on the Machkund river are harnessed. This river is one of the sub-tributaries of the Godavary. In the composite Madras State prior to the partition of Orissa, surveys of hydro-electric potentialities were carried out in 1929 and a comprehensive report drawn up by Sir Henry Howard in 1931. With the formation of the Orissa State in 1936, Machkund river became the boundary for Madras and Orissa near the project site. The Machkund hydro-electric project is a joint venture of Orissa and Andhra. Although jointly owned, it is being constructed under the direction and supervision of the Andhra Government Electricity Department.

The ultimate power potential is 1,02,000 kW. Half this capacity viz. 51,000 kW. is installed in the first stage. The power benefit and capital cost are shared by Andhra and Orissa in the ratio 70 : 30. The 132 kV transmission lines from the joint power station are, however, constructed by the individual states.

Project Works

The first stage development comprises :

(1) A main storage dam at Jalaput on the Machkund river, with a gross capacity of 25,650 M.Cft. and a net capacity of 25,400 M.Cft.

(2) A diversion dam across the river, 14 miles below Jalaput dam and 1½ miles above the Duduma falls with an effective storage of 389 M.Cft.

(3) Water conductor system covering :
- (*a*) A concrete lined flume channel 4034 ft. long.
- (*b*) Flume tunnel 4014 ft. long and lined with concrete.
- (*c*) Tunnel pond dam with forebay of 0.864 M.Cft.
- (*d*) Pressure Tunnel 2940 ft long, lined with concrete.
- (*e*) Surge shaft 50ft diameter and 75 ft deep.
- (*f*) Three penstock pipes each 1504 ft with a haulage track of 2150 ft. long.

(4) Power house with three units each of 17,000 kW capacity with space provision for three more units in the second stage.

Jalaput Dam

The Jalaput Dam now under construction forms the main storage reservoir for the Machkund hydro-electric scheme. It is located about 1½ miles below the confluence of Machkund and its chief tributary the Pathala. Work on this dam is expected to be completed by the end of 1957. The dam is 1220 ft long, with top width of 18 ft. and a maximum height of 148 ft. above the deepest bed level. The volumetric content of masonry is about 12.5 million cubic feet. The free catchment is 755 sq. miles yielding a continuous power draft of 1125 cusecs. Three steel discharge pipes each 8′ 6″ diameter are being embedded in this dam. These will be also used later to develop a maximum power of 20,000 kW. Two scour pipes 8′ 6″ dia. are provided near the power pipes to keep the intakes clear of silt.

The Jalaput surplus will be located in the saddle on the right flank. The length of the spillway is 550 ft. with eight gates of 60′×20″ to discharge a maximum flood of 1,49,000 cusecs.

The Machkund waters are charged with silt mainly due to the wasteful method of "podu" cultivation practised by the hill tribes. This problem is being effectively tackled by preventive measures, afforestation, and adopting silt exclusion devices in the design of the dam.

Diversion Dam

It is completed except for the erection of the gates in the spillway portion. The dam is 925 ft. long and is of a gravity type in solid masonry with a central spillway 560′ long with 8 nos. 60′×20′ crest gates designed to pass a maximum flood discharge of 1,85,000 cusecs. Two sluices 12′×8′ each (peak discharge 1800 cusecs each) for the intake of the flume

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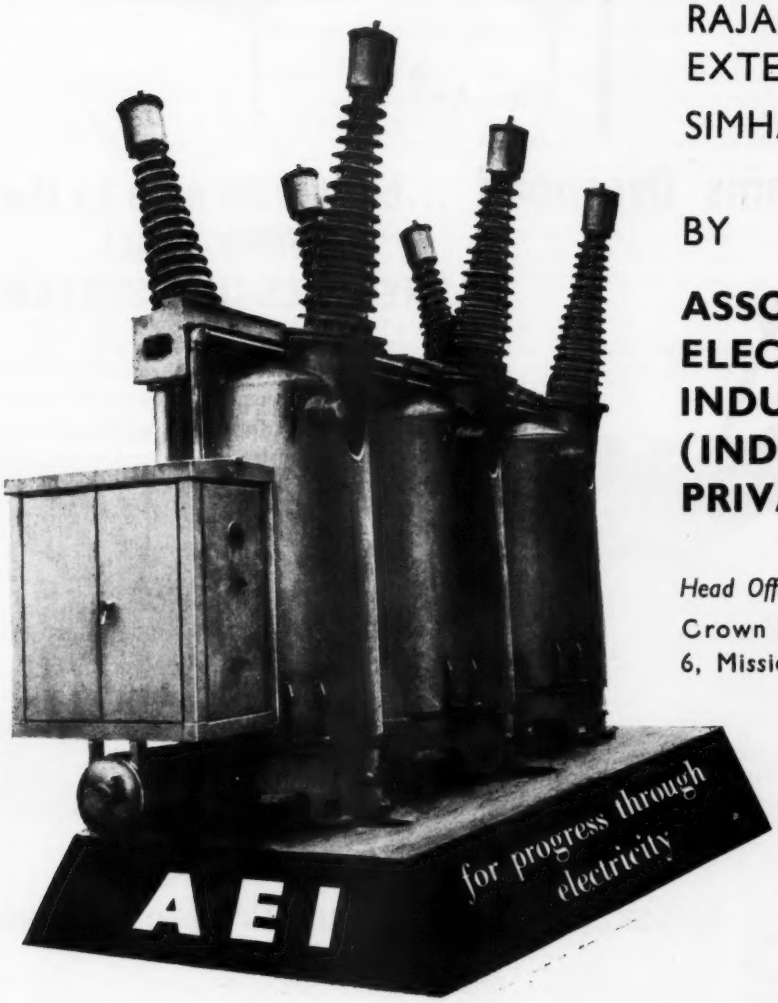

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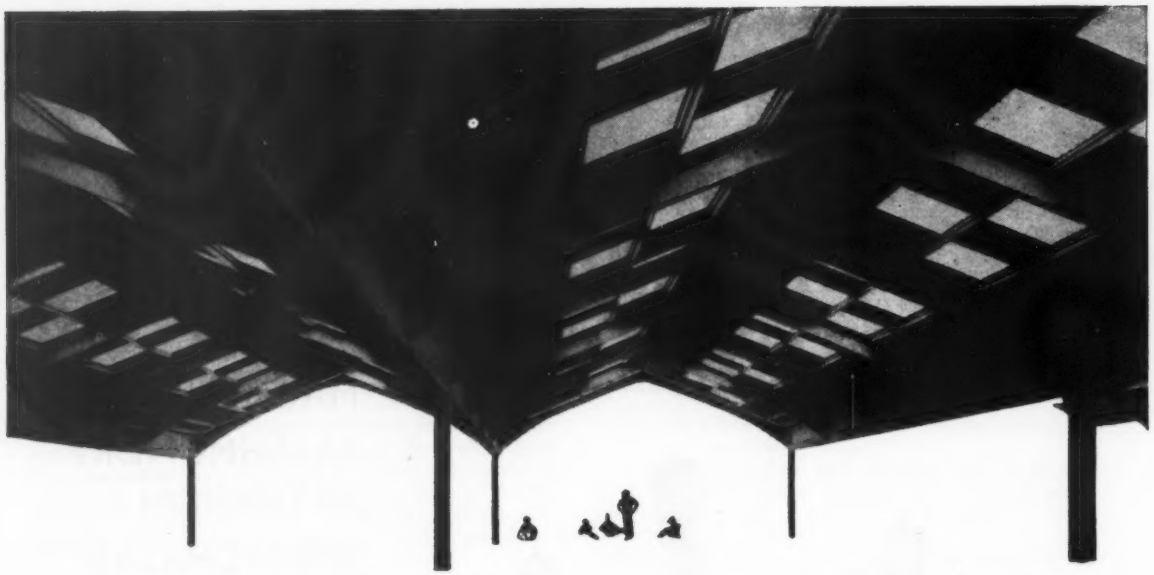

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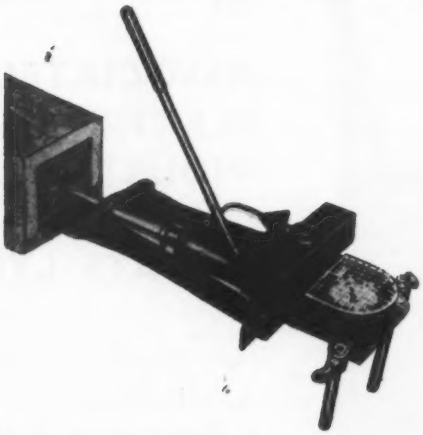

The primary beams for this factory were pre-cast in light, easily handled sections which were supported on false formwork before stressing: heavy and expensive lifting tackle was thus avoided. The Gifford-Udall System shows considerable savings in steel and concrete wherever pre-stressed concrete has an application; the same equipment has been used for post-tensioning 90 ft. span beams and pre-tensioning 30 ft. poles No royalties are payable.

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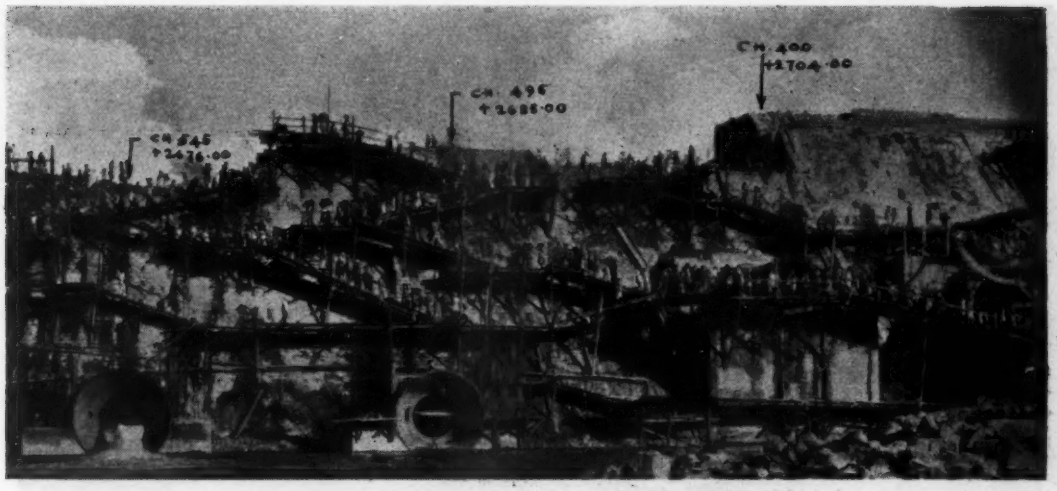


Progress of Jalaput Dam between ch. 400 and 545.

and one scour sluice 12′×8′ are located at the right flan k. The cubic contents of the masonry is about 2 million cubic feet. This diversion dam will provide a storage of 389 M.Cft for regulating and balancing purposes.

Flume and Tunnels

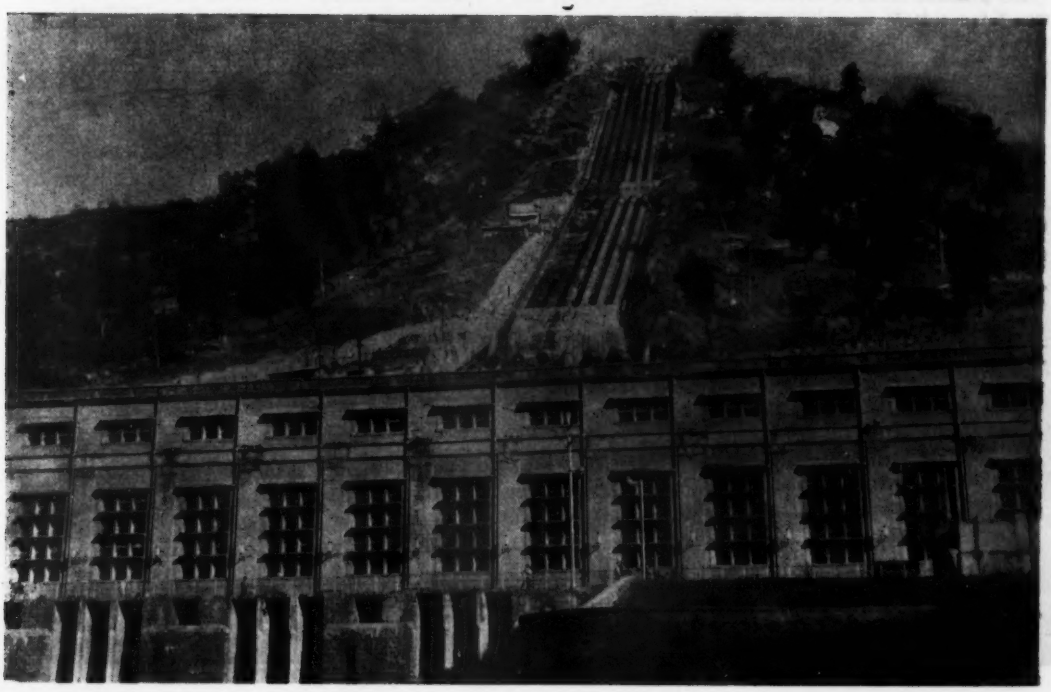
The water from the diversion dam is drawn through intake gates and conducted partly along an open concrete lined flume about 4034 ft long, (including 334′ of R.C. aqueduct) skirting the nill slopes on the right bank of the river. Next comes the free flow tunnel about 4014 ft. in length witn a sectional area of 238 sq. ft capable of handling 1800 cusecs peak discharge. Water from this flume tunnel discharges into the Makkiput valley where a regulating pond is formed by the "Tunnel Pond Dam," about 442 ft long and 60 ft high above the bed, with an effective capacity of about one m.cft at full reservoir level.

From the tunnel pond, water is conveyed through intake controls into a concrete lined pressure tunnel, approximately 2940 ft. long of 'horse-shoe' shape with a sectional area of 185 sq. ft.

Surge Shaft

The pressure tunnel ends in a surge shaft 50 ft internal diameter and 75 ft deep, excavated in rock

A view of the Machkund Power Station showing the Penstocks existing and under erection in the background.



Progress of Jalaput Dam Power stream side at ch. 800.

and lined with concrete. From the surge shaft, two steel pipes, each of 10 ft. dia. laid for a distance of 140 ft in a pipe tunnel, terminate into a three-way manifold, 66 ft. long. From these manifolds, three penstocks run down to the power house, and the three pipes of the second manifold are closed with blank flanges for connection to future penstocks.

Penstocks

Each penstock pipe feeds a generating unit. The penstock pipe is about 1504′ long, 63″ dia, for a length of 770 ft and 57″ dia. for the rest of the length. The shell thickness of pipe varies from 0.44″ to 1.56″.

At the head of the penstock and below the manifold, a butterfly valve 63″ dia. is provided. A high pressure valve 57″×48″ is also provided at the end of the penstock near the power house.

By the side of the penstocks, a haulage track runs down to the power house for the transport of men and materials.

Power Station

The power house is a steel framed building with course rubble masonry walls in superstructure. The sub-structure provides for two floors, the turbine hall and the generator floor. A switchgear annexe with a cable trench underneath, adjoins the machine hall on the upstream side. The main building of the power

The Jalaput Dam nearing completion. The Jalaput Reservoir is the main storage reservoir for the Machkund Station.

View of the Diversion Dam and the Flume channel taking off.

house including the switchgear annexe is 295′×60′ 9″ to house six generating units with all their auxiliaries and a house service unit.

The sub-structure of the machine hall portion is of reinforced cement concrete walls, 6 ft. thick taken down to the foundations 46 ft below the main floor level of the power house to suit the vertical type of the generating units. The generators are supported on independent r.c.c. slabs with beams of massive r.c.c. columns.

A 100-ton electrically operated overhead crane runs the full length of the machine hall to facilitate erection of the heavy machinery in the power house. The ground floor of the switchgear annexe accommodates all the 11 kV metal-clad switchgear and fire fighting and other associated equipment. From the main cable tunnel of the power house running the full length, connections are taken to 11 kV switchgear cubicles and to the outdoor yard. The main control panels, office and battery room are located on the first floor of the switchgear annexe. The cooling water and "Mulsifyre" pumps are located in a small extension at the eastern end of the power house below the ground floor level. The supply to the cooling water and "Mulsifyre" systems is taken from the tail race pool.

Generating Sets

Each 17,000 k.W. generating unit is directly coupled to a 25,000 H.P. Francis vertical reaction type turbine. The voltage generated is stepped up from 11 kV to 132 kV through banks of single phase 6670 kVA transformers located in the outdoor yard and connected to the generators on the unit system. The machines are paralleled on the high voltage side.

A 500 kVA capacity auxiliary generating set is installed for emergency use.

Transmission System (Andhra Side)

The power generated at Machkund Power House is transmitted by a double circuit 132 kV transmission line as far as Nellore District about 450 miles from Machkund. The total mileage of 132 kV double circuit line is about 570 circuit miles and that of single circuit line about 200 miles. All 132 kV lines are supported on fabricated steel towers.

The transmission lines are routed so as to link up with the existing thermal stations at Visakhapatnam, Vijayawada and Nellore. The thermal stations are required to supplement the Machkund power till adequate water storage is made available by completing the Jalaput Dam. The thermal stations will remain as "standby" thereafter.

Salient particulars of the Trunk lines fed by the Machkund hydro station

Transmission Line	*Voltage*	*Length*	*Power Conductor Size*	*Copper Equivalent in sq. inch*
Machkund—Tennubodduvara—Visakhapatnam	132 kV Double Circuit	90 miles	37/0.118 ACSR	0.20
Visakhapatnam—Rajahmundry—Bhimadole—Vijayawada ..	do.	195 miles	37/0.110 ACSR	0.175
Vijayawada—Ongole	132 kV Single Circuit	81 miles	6/0.186 plus 7/0.062 ACSR	0.10
Tennubodduvara—Nellimarla ..	do.	23 miles	37/0.102 ACSR	0.15
Machkund—Jeypore—Rayaghada ((Orissa feeder)	do.	92 miles	37/0.110 ACSR	0.175
Ongole—Nellore line	66 kV Single Circuit line	75 miles	7/.144 ACSR.	0.06

Grid Substations

The power transmitted at 132 kV from Machkund will be stepped down to 33 and 11 kV for secondary transmission and distribution purposes at the following substations :—

Substation	*Installed transformer capacity (in kVA)*
Nellimarla	12,000
Simhachalam (near Visakhapatnam)	27,000
Bommur (near Rajahmundry)	26,500
Bhimadole	8,000
Gunadala (near Vijayawada) ..	22,500
Tadepalli	37,500
Ongole	11,500
Nellore	6,000
Jeypore	5,000
Rayagada	15,000

The thermal station at Visakhapatnam is connected to the hydro electric system by double circuit 33 kV line from Simhachalam and that at Vijayawada by another 33 kV line from Gunadala hydro substation.

The following important places in the districts in Andhra will be receiving power.

Srikakulam district ..	.. Shikakulam, Garbham, Bobbili, Parvatipuram, Narasannapeta, Tekkali.
Visakhapatnam district ..	.. Visakhapatnam, Simhachalam, Chittivalasa Bnimilipatnam, Vijayanagaram, Nellimarla, Penubarthi, Kasimkota.
East Godavari district ..	.. Kakinada, Rajahmundry, Peddapuram, Pithapuram, Tuni, Ramachandrapuram, Amalapuram.
West Godavari district ..	.. Eluru, Bhimadole, Nidadavole, Palacole, Narasapur, Bhimavaram.
Krishna District	.. Masulipatam, Vijayawada, Jaggayyapeta, Vuyyuru, Gudivada, Nuzvid.
Guntur District	.. Guntur, Tenali, Narasaraopet, Bepatla, Chirala, Ongole, Tadepalle.
Nellore District	.. Nellore, Gudur, Nayudupet, Sulurpet, Venkatagiri.

On the Orissa side, the districts of Koraput and Ganjam will get benefited by Machkund Power. Power lines are being extended by Orissa State to Jeypore and Rayagada and later on to Berhampore thus covering the southern portion of the State.

Communication

In this modern are of industrial development, reliable and uninterrupted supply of power is essential to avoid loss of production and dislocation of labour. To facilitate efficient system control and operation, carrier current communication has been installed. This is a unique feature introduced in South India for the first time. This system uses the power line conductors themselves for transmission of speech signals at high frequency, without interfering with power transmission and has been working satisfactorily.

At Bommur sub-station near Rajahmundry, there are 2 nos. 7500 kVA synchronous condensers for improving voltage regulation beyond Rajahmundry and also ensuring system stability.

Capital Cost of the Scheme

The details of the capital cost for the joint scheme and the entire scheme on the Andhra side are furnished at the end in a tabular statement. The Andhra share of capital cost works out to about Rs. 15 crores initially rising to about Rs. 19½ crores at the end of ten years.

Load Prospects

It is gratifying to note that large blocks of power demands such as Caltex refinery at Visakhapatnam, ferro-manganese industry at Garividi, Fertiliser factory sponsored by Government of India at Vijayawada and Cement factories at Vijayawada and Macherla are expected to come up soon and accelerate the load development much faster than envisaged in the scheme load forecast.

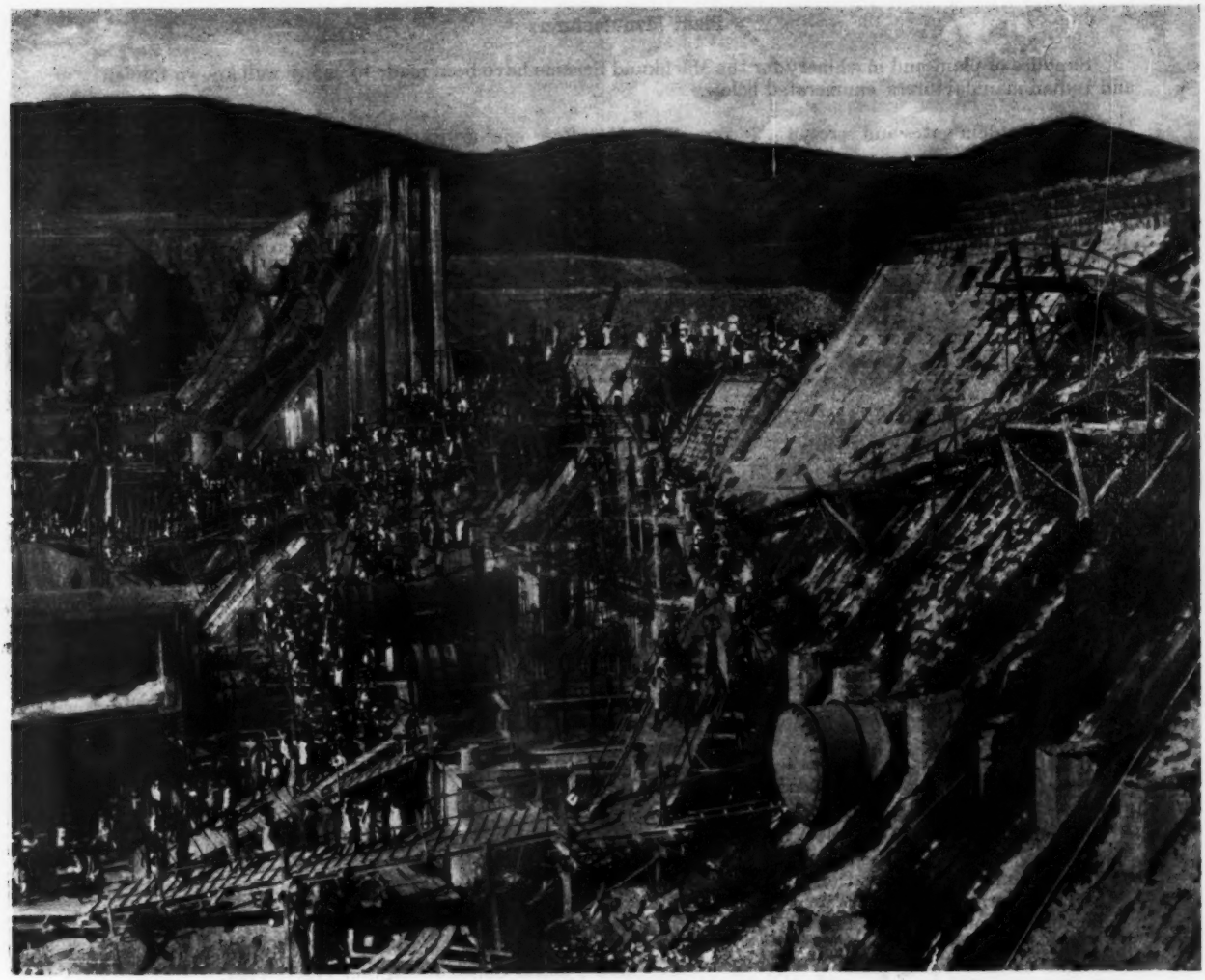
The project site being 120 miles away from railhead accessible only by a road passing through difficult ghat section constitutes a unique transport problem. Scarcity of labour in this remote backward area, involving large scale import of labour, severe weather conditions limiting the working period to about 9 months in the year, incidence of malaria and other difficulties had to be overcome.

The target date of September 1956 for the commissioning of the first generating unit envisaged in the composite state of Madras, had to be advanced and construction schedules accelerated after the formation of the Andhra State due to lack of hydropower in the new-born State. By working round the clock, new records were achieved. From foundations of the power house to completion of the first unit in 18 months is a gratifying progress.

Conclusion

To the people of Andhra to-day, Machkund signifies a big step forward heralding a new tempo of development of industries, agriculture, cottage and rural industries.

The First five Year Plan for power projects for Andhra, culminating in the commissioning of the first stage of the Machkund hydro-electric scheme, is bound to quicken the pace of development in this new born State.



Another view of Jalaput Dam under construction

Tabular Statement of Capital Cost for the Joint Scheme and Entire Andhra Scheme

S. No.	*Particulars*	*Capital cost initial*	*At the end of 10 years.*
		Amounts in lakhs of rupees	
I.	**Joint Scheme**		
	Joint scheme (Civil Works and power station)	926.05	1356.93
	Andhra share of capital on joint scheme (70%)	648.23	949.85
	Orissa share of capital on joint scheme (30%)	277.82	407.08
II.	**Andhra Transmission Scheme**		
	Transmission lines	587.08	601.83
	Substations and 132 kV feeder control equipment at Machkund	272.40	293.96
	Thermal stations	..	100.06
	Total for Andhra Transmission scheme	859.48	995.85
III.	**Overall Andhra share of capital cost**	1507.71	1945.70

Plant Manufacturers

Supplies of plant and machinery for the Machkund Scheme have been made by many well known foreign and Indian manufacturers, enumerated below.

1. Diversion dam gates and screens	M/s. Ransome & Rapiers England. (Director-General India Store Dept., London).
2. Tunnel pond gates and screens	M/s. Dortmunder Union Germany (M/s Kamani Engineering Corporation Ltd., Bombay).
3. Winch and haulage track	M/s. Wild & Co., England. (Director-General, India Store Dept., London).
4. Haulage track materials	M/s. Robert Hudson & Co., England.
5. Penstocks	M/s. Ferrums, Poland (Director-General, India Store Dept., London).
6. Butterfly valves	M/s. Boving & Co., England.
7. Turbine inlet valves	M/s. English Electric Co,. England (M/s. Binny & Co., Madras).
8. Turbines	M/s. S. Morgan Smith & Co, U.S.A. (M/s. Crompton Engineering Co., Ltd, Madras).
9. Surge shaft intake gates	M/s. Dortmunder Union, Germany. (M/s. Kamani Engineering Corporation Ltd., Bombay).
10. Butterfly valves and hollow jet valves for Jalaput dam	M/s. Neyrpic, France (M/s. Batliboi & Co., Madras).
11 Gates, screens and hoists for Jalaput dam ..	M/s. Dortmunder Union, Germany. (M/s. Kamani Engineering Corporation Ltd., Bombay).
12. Pipes for Jalaput dam	M/s. Garlick & Co., Bombay.
13. Spillway gates and hoists for diversion dam and Jalaput dam	Tungabhadra Dam Workshops, Hospet.
14. Tunnels	M/s. John Mowlem & Co., England.
15. Power House, Diversion dam, flume channel, Jalaput dam and Godavari river crossing piers	M/s. Gannon Dunkerly & Co., Ltd., Madras.
16. Tunnel pond dam, excavation of power house and transformer yard, tail race, penstock grading and Jalaput dam	M/s. G. S. Dugal & Co., Poona.
17 Krishna River crossing piers	M/s. Pioneer Construction Co., Vijayawada.
18. Generators and indoor switchgear	M/s. Westinghouse International Trading Co., U.S.A. (M/s. Crompton Engineering Co., Ltd., Madras).
19. Power Transformers	M/s. Ferranti, England (M/s. British Insulated Callender Cables Ltd., Madras).
20. Outdoor yard and switchgear	M/s. B.T.H. England (M/s. Associated Electrical Industries (India) Ltd., Calcutta).
21. Power house crane	M/s. Demag, Germany (M/s. Kamani Engineering Corporation Ltd., Bombay).
22. Power house steel work	M/s. Chitram & Co., Madras.
23. Transmission lines	M/s. British Insulated Callender Cables Ltd., Madras, M/s. S. A. E., Italy, and M/s. Crompton Engineering Co., Ltd., Madras.
24. Substations	M/s. Crompton Engineering Co., Ltd., Madras, M/s. Reyrolle Agency, Calcutta, M/s. Associated Elecl. Industries (India) Ltd., Calcutta, M/s. Easun Engineering Co., Ltd., Madras, M/s. English Electric Co., Ltd., Madras and M/s. Voltas Ltd., Madras.
25. Carrier communication equipment & condensers	M/s. Brown Boveri, Switzerland (M/s. Voltas Ltd., Madras).

Construction of Concrete-lined Tunnels for the Machkund Hydro-Electric Project

By G. A. GAULD

The Machkund 100,000 kW. Hydro-electric Project is located some 130 miles by road, north-west of the South Indian port of Vizagapatam in undeveloped hill country on the Machkund river which, in this area forms the boundary between the States of Madras and Andhra Pradesh. The project was inspired by the 540-foot drop of the Duduma Falls. Sponsored jointly by the two States, it is being constructed under the supervision of the Madras Government Electricity Department.

The Project includes two concrete lined tunnels, the sections being shown in the accompanying diagram. The Flume Tunnel is some 4,110 feet long, and the Pressure Tunnel, including a short Pipe Tunnel at the end, totals 3,090 feet.

This article describes the construction of the tunnels from the contractor's point of view.

Plant and Maintenance

The need for completing the tunnels within a reasonable time together with the relatively high cost of postwar labour led the contractors to their decision to mechanise the work as far as was compatible with local conditions.

The majority of the mechanical and electrical equipment employed was imported direct from the U.K., only a few small items being obtained in India from agency firms. All plant was sent out complete with a suitable stock of spares and a stores and supply system was built up to maintain these stocks at the required level. To supplement this system and to deal with the manufacture of special equipment at site, a small workshop was established having all necessary machine tools, testing equipment, and general maintenance facilities.

The use of labour, inexperienced in the maintenance of modern equipment, called for special methods of handling the problem. Drivers were permitted only to clean their machines. For weekly and shift maintenance, routine schedules were drawn up and the work carried out by mobile, specialized gangs, headed by a change hand who had been trained in the work. In the event of a breakdown on a heavy piece of equipment which could not conveniently be moved, a repair gang, specially trained in that group of equipment, went out to the work site and effected the necessary repairs. Where equipment was light and portable, it was brought into the central workshops, where it was dismantled under clean conditions, and repaired by suitably trained men, under the general supervision of the workshops foreman

This policy did increase the labour costs of repair and maintenance, but the policy was justified by the high degree of plant reliability obtained.

Training of General Labour and Supervision

For the specialized trades, suitable men were recruited from the surrounding towns and villages and with adequate supervision, carpenters, masons, fitters electricians, and the like, discharged their duties remarkably well.

For work in the tunnels, however, it was necessary to bring in good raw material and to face up to the task of training it. Men of good physique and, preferably with some previous experience of construction work, were brought in, often from considerable distances. One a small nucleus had been adequately trained, expansion was relatively simple.

A new starter would commence work as labourer on the tip: then, if suitable, he would be transferred to work inside the tunnel. The drillers' helpers were recruited from these tunnel labourers and, after training, suitable men were selected for promotion to drillers. From this group, the necessary gangers and shift bosses were ultimately obtained.

In the earlier stages of training, the wastage was heavy but, by steady work and by exercising much patience a fine team of men was built up.

Special care was taken with the men who were to handle explosives. The safety regulations were explained to them and training given in all aspects of the blasting procedure, special attention being paid to such matters as dealing with misfires. Men were allowed to handle explosives only after passing the test which followed their training. The issue of a certificate together with an increased rate of pay supplied the

necessary incentive, and the system was justified by the low accident rate which resulted.

The majority of the men who reached the higher positions proved to be readily adaptable. There was, therefore, no difficulty in obtaining the right type of men for further training to make up the concreting crews when the linings were commenced.

For most of the time, the labour strength amounted to about 800 men, although it peaked for a few months to over 1,000. In the early stages, ten Europeans were employed. However, men selected out for training in responsible posts quickly showed self-reliance, initiative and the sense of urgency necessary to the successful development of a large contract, with the result that the European staff was soon reduced to six.

Method of Driving

Although soft and shattered rock was encountered in places, and although it was often heavily jointed, it was, on the whole, a hard, blue, close-grained granitic gneiss. This was largely responsible for the decision to use tungsten carbide tipped drills. This, in turn, led to the adoption of light rock drills mounted on airlegs.

The tunnels were wide enough to admit two 2-foot gauge tracks and permitted the simultaneous operation of two air-driven rocker shovels in each face. Wagons were changed over by a wagonslide, operating between the two tracks close behind the shovels, and one diesel locomotive per face proved to be adequate for handling the wagon trains to and from the spoil tips.

The round time was reduced by employing a method whereby, to a large extent, simultaneous drilling and mucking was possible, the sequence of operations being as follows.

As soon as the fumes from the blast had cleared—an operation involving blowing in fresh air at the face from the compressed air mains, coupled with the running of the exhaust fans which drew out the foul air through the ventilation ducting part of the drilling gang went into the face and trimmed down all loose rock. The remainder of the drilling gang brought in the drilling equipment and set this up on the muckpile for drilling the middle group of holes. At the same time, the rocker shovels were brought in and put to work at the toe of the muckpile which usually extended some 50 or 60 feet from the face.

When the middle group of holes was completed, the muckpile was normally reduced to about 15 feet from the face. Work was then stopped while the suspended platform was rigged.

This consisted of two girders, each made up from a pair of 2-inch pipes with angle bracing welded in between. Holes were drilled into the tunnel walls on each side to correspond with the positions of the open ends of the girder pipes. Thus, by inserting short steel bars, each half-way into the appropriate hole, and halfway into the corresponding open end of the pipe, each girder was supported from the tunnel walls. A timber decking was added, and from this platform, the drillers tackled the top group of holes while the rocker shovels completed their work underneath.

This left the bottom holes to complete the round. The shovels were withdrawn and the bottom holes drilled with the machines set up on the tunnel floor. During this period, the mucking gang laid in fresh tracks, extended and cleared the tunnel drains, and assisted in bringing in the explosives.

With all the drilling completed, the holes were charged, the platform dismantled and removed together with all other equipment, and the round fired, completing the cycle.

Round times, naturally, varied considerably according to the conditions appertaining at the time, but the following may be taken as a fair average :—

	Hr.	Min.
(1) Waiting for fumes to clear after the blast before re-entering the tunnel	0	50
(2) Taking equipment up to face, barring down loose rock, clearing track, reconnecting air mains, etc., in preparation for mucking	0	30
(3) Mucking, including an average of 30 minutes delay for erecting suspended platform	8	00
(4) Drilling lower holes	3	00
(5) Charging face, testing, removal of equipment, blast	1	45
Total	14	05

The normal work of driving the faces was stopped for the greater part of Sundays, so that general maintenance work could be carried out. Thus aiming at an eight-foot round, the average progress was usually over 80 feet. The best performance for one normal week was an advance of 130 feet at the inlet face of the Flume tunnel.

Comments on Driving

Both detachable cruciform tipped bits and chisel-shaped steels were employed. Both types were readily reground when worn, but some extra work was required in the case of detachable bits in forming the tapers on the drill rods to which they were fitted. Breakages at the connection were not uncommon and these frequently led to the loss of the bit in the hole in spite of the use of magnetic extractors. Much of this trouble was dut to the inferior quality of steel, the only quality available at the time, from which the drill rods were forged.

The chisel-headed steels had a greater tendency to jam, particularly in jointed rock, and steels were lost occasionally from this cause. In most cases, the tungsten carbide tips reached the end of their useful life before there was any failure of the shank, the latter being made of the best quality Swedish steel. Consequently, there was little need for reforging, the steels being scrapped when worn out.

Taking into account bit and steel losses as well as normal wear, the average drilling obtained was:

	Feet of hole
Cruciform detachable bits	137
Chisel tipped steels	288

Taking into account also the materials and labour costs, the tipped steels showed the lower cost per foot of hole drilled. However, a careful analysis of the results suggested that, had first-class steel been available for making up the drill rods for the detachable bits, there would have been little to choose between the costs of the two types. The advantage would then be with the cruciform bits if working in heavily jointed rock.

In broken ground difficulty was experienced with rigging the suspended platform causing delay, but apart from this, the method was satisfactory. The capital equipment was much less costly than that required for the drill carriage technique and had the undeniable advantage of permitting simultaneous drilling and mucking and so reducing the round time.

The muckingshowed up one serious fault: the quality of the wagons. Common 1. c. y. tip wagons were used and these proved to be far too weak to stand up to the heavy duty imposed by the rocker shovels. Not only was the cost of maintenance of the wagons very heavy, but so many were out of sevice and under repair, that the wagons available for mucking were frequently below minimum requirements, resulting in unnecessary delays. To secure the full advantages of rocker shovel loading, it is thus necessary to employ a heavy pattern of wagon properly designed for the job.

It will be noted that the time required to clear the fumes after blasting formed an appreciable portion of the round cycle time. In addition to the exhaust fans located at the ends of the ducting at the tunnel portals, one booster fan was introduced into the ducting within the tunnel in each face. These were very effective and it is considered that the fume-clearing time would have been appereciably reduced had more of these booster fans been available.

Fog, arising from the machine exhausts, made working at the face unnecessarily difficult and probably led to avoidable delays. The provision of after-coolers and water separators at the compressors would have eliminated this trouble, and the purchase of such equipment would appear to be advisable for tunnel work in the relatively warm and humid atmosphere of sub-tropical areas.

A "burn" cut with the usual easers and trimmers was employed and the holes were fired in the required sequence with electric delay action detonators. Provided due care was given to all connections, little trouble was experienced. With good and accurate drilling, a clean square round was normally obtained.

Special Section

In two short sections where the rock was badly shattered conventional steel ribs formed from R.S. Js. bent and welded to shape were employed to support the sides and roof. However, steel was limited in availability for this purpose, and costly, and another method was used in two other sections of soft and broken ground.

The face was carefully opened out for a distance of nine or ten feet ahead, the roof being temporarily supported with rails and timber. Under cover of this, rough side walls were built up by hand in concrete, the shutters being set to give a clearance of about nine inches outside the finished surface of the lining. Rail ribs were added to provide arch reinforcement, and a similar arch built up in concrete to complete an outer lining. Under cover of this, the next length was opened out and rough lined and so on until sound rock was again encountered when normal methods were resumed. This rough work was, of course, covered up when the normal lining was placed.

Preparation for Lining

With the muck track in the middle, the sides were roughly cleaned out and any tight places in the lower portions of the tunnel side walls were trimmed. With this done, two gangs were next employed, one to clean out the middle of the floor and trim out any high spots, while the second gang, aided by air water jets, cleaned out the floor thoroughly to bare rock, removing any material which was broken and loose.

Cross screeds were then set in to six inches below the level of the finished invert, being mounted on special precast concrete blocks. A further set of larger blocks was also positioned to carry the track over the screeds. Using this track and ordinary tip wagons, concrete was brought in from the batching and mixing plant outside and the initial invert, or concrete mat poured.

Another small gang followed behind to cast in shallow side kerbs. These located the shutter skirts which were to follow and also provided a means of correctly positioning the travelling profile and trimming gantry. This had two profiles, one fixed and 12 inches smaller all round than the minimumrock line. Tight Places were marked from this and trim med. A folding Profile, shaped to the minimum rock line, was then erected, and the clearances checked by pushing the gantry through the section trimmed.

Equipment for concreting Arch and Sidewalls

In the interests of speed and good finish, there was no hesitation in deciding to use a steel travelling shutter. This shutter, 40 feet long, was designed and constructed in the U. K. It included a few extra parts which enabled it to be adapted for use in both tunnels and it was carried on a broad gauge, heavy tract, laid on sleepers on the initial invert floor.

Considerable thought was, however, given to the concrete placing equipment. Hand placing was ruled out as being too slow and probably too costly. The choice thus lay between the employment of a concrete pump or a pneumatic placer. A concrete pump normally produces a satisfactory concrete whereas a pneumatic placer is liable to produce segregation of the concrete materials unless special precautions are taken to prevent this. On the other hand, a pneumatic placer is normally free from mechanical troubles whereas a concrete pump is prone to mechanical breakdowns, blocked pipes and other troubles unless expertly handled. With untrained labour in view, it was ultimately decided to employ a pneumatic placer,

ample compressed air from the compressors installed for the drilling being available to operate it.

The lining equipment was thus composed of five units, all of which, other than the pipe tower, were linked together, running on the shutter tracks, so that they could be hauled forward as required by a hand winch.

The first section consisted of a wagon ramp and belt elevator. The 2-foot tip wagons containing the batched aggregates were hauled up the ramp by an air winch and tipped into the elevator hopper. At this point, cement was added and the whole discharged into the storage hopper of an electrically driven 1.c.y. mixer. On discharging the mix from the drum, the batch from the storage hopper was released, and the storage hopper again refilled. Thus a steady input was assured.

The discharge chute from the mixer led straight into the next unit, the pneumatic placer. The placer discharge pipe was led up, and supported on the carriage on which the necessary air receiver was mounted, the last linked unit of the equipment.

Between the air receiver carriage support and the shutter, the pipe received further support from a pipe tower. This travelled on the same tracks but was moved independently as required, as the pipe was withdrawn from the shutter towards the end of the pour.

The batching plant, site-made was located outside the tunnel portal, and consisted of timber hoppers fed both directly by wagons on an elevated track leading from the crushers, and by portable conveyor units fed from the crusher and washed and stockpiles. In front of each hopper, at a height which permitted the passage underneath of locomotives and wagons, there was a batching deck. As the specification called for volumetric batching, fixed gauge boxes were let into and flush with the deck, which simplified the process of screening off surplus material. They were equipped with steel bottom doors, fitted with counter weights to make them self-closing, providing for their rapid discharge into the wagons below. The aggregates were fed to the gauge boxes through gate-controlled chutes.

The whole plant provided for two grades of crushed rock aggregate and one of sand, the gauge boxes being duplicated in each section to permit simultaneous batching into two wagons at a time. Each wagon contained one mixer batch and, in this way, trains of batched material were rapidly made up and despatched at the rate required to meet the demands of the pneumatic placer.

With each train, a flat bogie was included carrying the correct number of bags of cement for adding to each batch at the elevator hopper.

Technique of Placing

Once the concrete builds up to its natural slope and rises into the arch so that the end of the placer discharge pipe may remain buried to the extent of a foot or two, the problem of segregation largely disappears. In the relatively large tunnels at Machkund, however, several hours elapsed before this condition was reached and special precautions were necessary to prevent the occurrence of honeycombing in the lower portions of the tunnel walls in the areas first poured.

Concreting was commenced by first shooting some six batches of cement and sand mortar followed by the normal mix (4:2:1). Throughout the next phase of the operation, a few seconds' vibration was applied to the shutter immediately after each batch had been shot. Heavy pattern insertion type vibrators were used being fitted into clamps welded into the shutter ribs so that the vibrators could be moved at intervals along the shutter to keep pace with the concrete. At the same time, the concrete was constantly punned by hand, the men working through the inspection panels provided in the shutter.

Once the condition was reached in which the discharge pipe could be buried and progressively drawn out as the arch filled up, little trouble was experienced other than that which might be termed a dirty shutter effect. While pouring the walls, a certain amount of concrete splashed over the crown, forming a patchy skin, less than an inch thick. If the shutter was left in this condition, the splashed material tended to cling to the shutter on striking, so leaving an uneven finish to the crown. The remedy was to stop work when the sides were filled and to clean off the crown. As crown inspection plates were provided this could usually be accomplished except where the roof clearance was particularly low.

The buried pipe technique exerted a compacting effect on the arch concrete, pushing it up into the cavities which, in normal conditions, were filled tight, far better than they would have been by any other method. Subsequent grouting operations proved this point.

Interruptions to pouring from any cause tended to produce "cold joints", i. e. a thin layer of honeycomb lying on top of the concrete surface where pouring had stopped. This fault was eliminated by chipping the surface, if accessible, and by shooting in one or two batches of sand and cement mortar on resuming operations prior to following on with the normal mix.

For satisfactory operation and finish, the water content had to be controlled within close limits. If the concrete was too dry, there was a danger of blocking the discharge pipe, particularly under the buried condition. If the concrete was too wet, water marks appeared on the surface of the finished work on striking the shutters. This appeared to be due to the water in the concrete being squeezed out as more and more concrete was added on top, and this tended to travel upwards to the surface over the shutter skin, washing out a minute portion of the cement grout in the process. Thus, rivulets having a sandy skin would show on striking. They did not affect the strength as their depth was little more than onesixteenth of an inch, but they did spoil the smooth, hard, glossy finish normally obtained. However, careful control over the water gauge at the mixer reduced the fault to negligible proportions.

After suitable tests were made in the early stages, it was found possible to strike the shutters and move them forward sixteen hours after the pour was completed.

This made possible an average of five lengths or 200 feet of lining per week.

Maintenance of the Concreting Eqiupment

As with the other mechanical plants, a schedule for routine maintenance was laid down and, furthermore, a preparation schedule which made sure that every point had been checked and that nothing had been over-looked so that once a pour had been started, it could be expected to proceed without interruption until completed.

The pneumatic placer gave no mechanical trouble and build-up welding of the throat with hard alloy was required only after completion of some 8,000 c. yds. of concreting. The top bend of the placer discharge pipe was supplied with special wear plates. These did not wear out uniformly and by adopting a special sequence of replacement and rearrangement, the maximum life was obtained. Build-up welding was required in portions of the bend fairly often and two bends were constantly employed, one in service and the other in the shop for reconditioning.

A special sleeve joint was locally designed and made to couple the six-inch steel discharge pipes which enabled the pipes themselves to butt together with no reduction in the metal thickness. Wear was greatest along the bottom of the pipes and, to distribute this wear, the pipes were rotated through 120 degrees after each pour. Wear was least near the bend and maximum towards the open discharge end where the concrete attained its maximum velocity. By employing a progressive system of replacement, the life of the pipes was extended to the maximum. On average, one set of pipes sufficed to complete about 20 lengths.

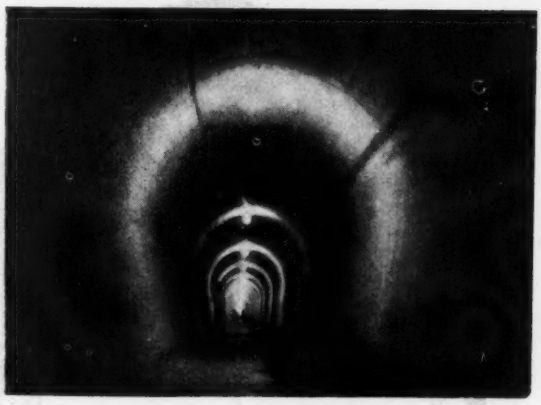
The air pressure used has a marked effect on pipe wear. The suppliers of the placer had recommended a working pressure of 120 lbs. per sq. inch, but experiments soon showed that results were entirely satisfactory with 100 lb. on the compressor house gauges giving some 90 lbs. working pressure at the placer. The lower pressure appeared to reduce the pipe wear by 50 per cent or even more.

The rest of the equipment gave little trouble. The large quantity of concrete passed through the mixer caused considerable wear of the drum, but this was remedied at intervals by patching and build-up welding.

Concreting the Final Invert

The side wall shutters were designed to form a slight projection at the point of intersection of the walls with the final invert thus forming a screed guide. Immediately behind the travelling shutter, a centre screed was set up on the initial invert floor. On completion of the main pour, special sections of track were quickly laid in through the shutter and concrete run from the main mixer, through the shutter, and the wagon tipped on the floor. One half of the final invert was poured in this way, the correct form being obtained by a profiled tamper worked between the wall projection and centre screed.

It was convenient at this stage to leave the second half since it functioned as a drain for the tunnel works generally, taking care of all water used in washing down the rock walls, plant, etc. However, as the track



A view of the Machkund Tunnel

was taken up ahead of the mian plant, it was carried through the shutter and relaid behind on top of the finished half invert.

Thus, on completion of the walls and arch, and working with the some batching plant and mixer, the second half invert was soon poured by running the concrete in tip wagons along the track already laid. Again, the correct shape was obtained with the profiled tamper working between the other wall projection and the edge of the previously poured half-invert lying along the centre of the tunnel.

Surge Shaft and Pipe Tunnel

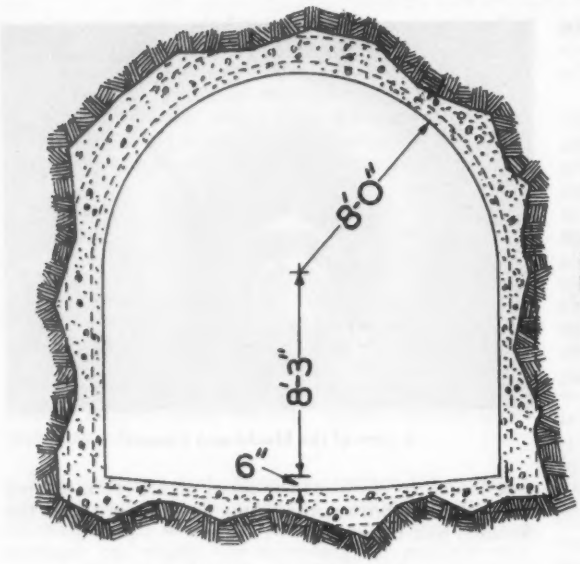
The tunnels contract also included the construction of a concrete lined surge shaft 50 feet in diameter, and 75 feet high, and a concrete lined pipe tunnel leading out of the surge shaft 32 feet wide by 21 feet high with a length of 110 feet.

On the surge site, a small pilot shaft was first sunk from an open cut on top. On completion of the Pressure Tunnel drive, the shaft was opened up to full size using the pilot shaft as a muck chute and loading by rocker shovel below.

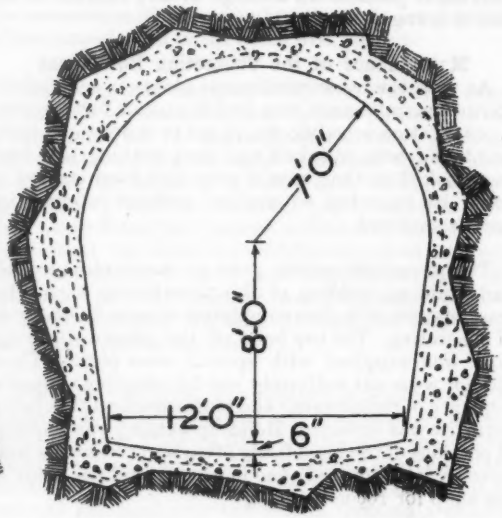
The problem of shuttering this enormous shaft was no easy task to solve but, finally, a system of steel self-supporting shutters was devised. This consisted of two complete rings, each two feet in depth, and built up in panels of convenient weight. At intervals, ten-foot long "soldiers" were introduced made from 10 inches by 3 inches channels. Everything was bolted together, the channels, with their greater overlap on the finished work, introducing greater vertical stability which helped to keep the work plumb.

At each pour, nuts with square washers welded to them to prevent rotation, were placed on the ends of greased bolts passed through the shutter panels and soldiers, and concreted in. When the lift had set, the bolts were tightened thus locking that top ring into position. The lower ring could then be unbolted, lifted on top of the fixed ring, bolted to it and together forming another two-foot lift rigidly supported on the pervious one.

The process was thus continued to the top, special timber shutters being introduced where junctions with other work occurred and where grooves or cavities



FLUME TUNNEL



PRESSURE TUNNEL

has to be left in the concrete for the subsequent fitting of steelwork.

With the shutters self-supporting, it was possible to build up a relatively light system of scaffolding with a right deck at the required levels to give the men access to each lift. A girder was cantilevered out at the top on a rock and concrete foundation, and fitted with a pulley. With this and an air winch a hoist was devised which lifted about 7 c. ft. concrete from the mixer at a time to the working deck from whence it was carried and placed by hand right round the ring until that lift was completed.

The side walls of the pipe tunnel presented no particular problem and steel-faced timber shutters were used, supported on L shaped frames which rested on the floor.

Since the tunnel arch was of considerable size, it was considered that much time and labour would be saved if the shutter was constructed as a one piece travelling unit. A length of 7'-6" was selected as being the most suitable. The arch form was made up in timber ribs with timber lagging covered by thin steel sheet and the whole was carried on four pipe column units suitably braced together. The feet of the columns did not extend to floor but were fitted with footplates. These were located above joist bedded on the floor with gap in between of some six inches to be filled by timber folding wedges.

The second framework was built which could be slipped under the shutter unit. This was built up on four bogies which ran on two feet parallel tracks.

To strike the shutter, the second unit was run underneath the shutter. The weight of the latter was taken by ordinary jacks sited on the tunnel floor and acting on suitable brackets welded to the shutter framework columns. The wedges were knocked out, the jacks lowered until the shutter framework rested on the second unit, and the whole assembly was then drawn forward by a hand winch into the next position. The shutter frame was jacked up, the wedges inserted and the supporting frame drawn out forward of the shutter. With the addition of a few planks, it now formed a working platform for the men who were to place the concrete in the arch.

A portable belt conveyor was withdrawn from the crusher site and used to convey the concrete from a mixer set on the tunnel floor to the working platform. From thence it was shovelled into the shutter.

With a setting time of 24 hours, a progress of three lengths, or 22'-6" was obtained per week.

Conclusion

Although the contractors had made their decision, considerable doubts existed at first as to whether or not it would prove to be practicable to combine the employment of modern plant and methods with untrained labour under the conditions which obtained at Machkund. There early doubts soon proved to be unfounded. By suitable training and supervisory control, the men acquired a remarkable degree of skill. The mechanical equipment served well, and the men soon dropped into the routine operations of maintenance, driving the tunnels and placing the linings. Progress bonus was introduced throughout as many operations as possible, and this kept interest and effort at the consistently high level necessary to maintain good progress.

To sum up, the correctness of the contractor's decision was proved by the results obtained which compared very favourably with Western standards.

Acknowledgement

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Ramagundem Thermal Power Scheme

By S. A. QUADER

The scheme envisages the construction of a thermal power station of 37,500 kW. capacity at Ramagundem on the Grand Trunk route between Kazipet and Balarshah. The site for the power station is located in the heart of the rich coal producing area and supply of coal to the Power Station is from the Bellampalli Collieries which is about 20 miles from the power station. There are also possibilities of opening a coal field at Ramagundem. The power plant comprises, of 3 alternators of 12,500 kW. capacity each, together with 6 boilers of 50,000 lbs per hour evaporation capacity each at 425 lbs per square inch pressure, turbines and associated equipment. The various civil works like colony quarters, roads, power house, workshop building, cooling tower etc., are complete. Erection of all 6 boilers as well as 3 turbo-alternators is over. The power generated at Ramagundem will be used for the following purposes :

1. To supplement the power supply at Hyderabad to meet the ever increasing demand for power in the metropolis.

2. For the supply of power to the districts of Karimnagar, Warangal, Nalgonda and Medak in Telengana region of Andhra Pradesh.

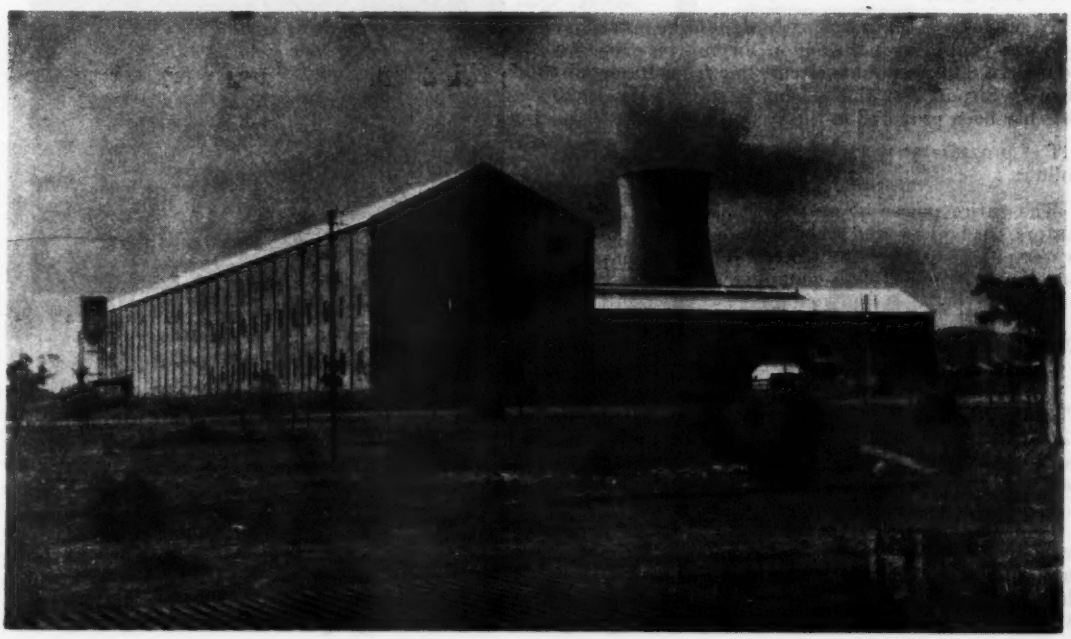
The transmission and distribution lines consist of :

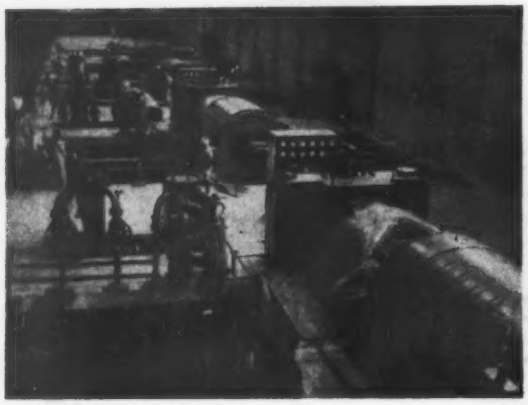
(a) one 120 mile double circuit 66 kV line running from Ramagundem to Hyderabad, supplying power on the way to Peddapalli, Karimnagar and Siddipet

(b) One double circuit 66 k.V. line from Ramagundem to Sirpur to cater for the heavy industrial load coming up at Mancherial, Bellampalli and Sirpur.

(c) One 66 k. V. single circuit line from Ramagundem to Hanamkonda.

General view of the Power House





Turbine Room

(d) A number of 33 k.V. lines for supply into rural a eas with subsidiary 11,000/440 V lines. At present 22 major towns and villages, increasing ultimately to 40, will be electrified and power supplied to lift irrigation sets along the route.

The communication between the power station and the various sub-stations will be by means of carrier system.

A noteworthy feature of the scheme is that all the transmission towers required for the project were designed, fabricated and erected by the departmental staff.

The total estimated cost of the original scheme is Rs. 406 lacs. The amount is revised to Rs. 500. 12 lacs.

Under the second Five Year Plan, it is proposed to increase the steam generating capacity of the station by the addition of one more boiler of 160,000 lbs per hour capacity and a cooling tower. A sum of Rs. 38.20 lacs has been provided for the scheme in the second Five Year Plan.

In order to cater to the needs of the large industrial concerns coming up in the region (Sirpur) it is proposed to erect a 66 k.V. double circuit line from Ramagundem to Sirpur. For this scheme a sum of Rs. 19.20 lacs has been provided in the second Five Year Plan.

The progress of work so far on the project is as follows :

The entire power house consisting of the 3 alternators, 6 boilers and their auxiliaries, circulating water pumps and cooling tower etc., were compl ted together with the main pumping station at river Godavari. The tests on all the boilers and alternators and 11 k.V. switchgear were carried out successfully. The power house has been commissioned in the month of June 1957 and power is being supplied now to the towns of Peddapalli, Sultanbad, and Mancherial.

The entire civil work such as colony roads etc., were also completed.

On the northern feeder the 66 k.V, double circuit transmission line from Ramagundem to Bellampalli which also includes the crossing of the river Godavari is completed.

The industrial concerns at Sirpur have come up for electricity supply for their factories demanding about 17000 kW of power. The estimate for the northern feeder has therefore been revised and government sanction obtained. The 66 k.V. single circuit transmission line from Peddapalle to Hanamkonda is in progress.

66 k.V. Line normal suspension tower

Continued from page 33

Telengana Hydro-Thermal Scheme

The number of villages and towns electrified is only about 15 out of 10,000 villages in the area. The development of electricity in rural areas which is of national importance in the country is practically nil.

To increase the standard of living and to improve the economic conditions of the rural population estimated as 80 per cent of the total population, it is essential that the electric supply is extended to villages rapidly. It is obvious therefore that a very board based policy in the matter of electric development is to be adopted in the Telengana area if any appreciable progress is to be achieved. The piecemeal sanction accorded by the Government and/or sought for by the department previously will not help vast and co-ordinated development that is desired. The policy of sanctioning schemes on an integrated development basis for large Zones as adopted in the case of ersstwhile Andhra area is all the more necessary in the case of Telengana area which is lagging behind.

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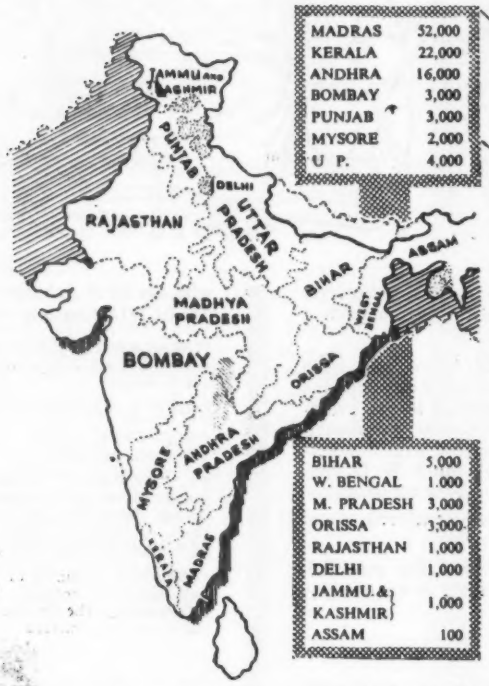

MADRAS	52,000
KERALA	22,000
ANDHRA	16,000
BOMBAY	3,000
PUNJAB	3,000
MYSORE	2,000
U P.	4,000

BIHAR	5,000
W. BENGAL	1,000
M. PRADESH	3,000
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RAJASTHAN	1,000
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Tungabhadra Hydro Electric Scheme

The Tungabhadra reservoir is primarily intended for irrigation but the possibilities of power development from its storage have been under consideration for a long time. The Tungabhadra Power and Tungabhadra Low Level canal are synonymous. It was in early 1939 that the possibility of Low Level canal for immediate use of the water of the Tungabhadra for irrigation at a comparably low cost was visualised and with it the possibility of developing power at different stages examined. One such was to develop a single fall at Bukkasagar and another further away from Mallapur and Kampli villages. Development of power in two stages at Dam site and at Kamalapur was finally decided on and canal aligned to suit. The reservoir is formed by constructing a dam across the river Tungabhadra near Mallapuram about 3 miles from Hospet in Mysore State. The river takes its present name from the confluence of the Tunga and Bhadra. These two rivers have their source in the hill known as "Varaha Parvath" high up in the Western Ghats in Mysore State. After running widely different courses, they unite at the sacred village of Kudali near Shimoga to form the Tungabhadra. This river forms the boundary between Andhra Pradesh and Mysore States, lower down the Bellary District of Mysore, before finally joining the Krishna River.

The Tungabhadra Hydro Electric Scheme is one the major multi-purpose projects undertaken in composite Madras State, firstly as a post-war development project and later added to the first Five Year Plan. With the formation of Andhra State, and the consequent transfer of the seven taluks of Bellary District to Mysore State, this project has become a joint venture of the Andhra Pradesh and Mysore State Governments. The capital cost on the project and the power benefits are shared in the ratio of 80:20 on a permanent basis, but this ratio is agreed to be 75 : 25 until the first unit of Sharavati valley project of Mysore Government is commissioned. The execution of the project is under the control of the Tungabhadra Board, which is constituted by Government of India specially for the purpose. The constitution of the Board is furnished in Annexure. I.

The ultimate installed capacity of the scheme is 72,000 kW. Of this, 45,000 kW have to be installed in the first stage (2 units of 9,000 kW at Dam and three units of 9,000 kW at Hampi) and the rest under the second stage. Four units of 9,000 kW each are already installed and arrangements are being made to instal four more units of the same capacity during the second Five Year Plan.

The first stage of the Project comprises :

(*a*) A power station at the foot of the Tungabhadra Dam called the Dam Power House with two 9,000 kW units and provision for two more units in the future.

(*b*) A second power station called the Hampi Power House at about the 14th mile of the irrigation canal, near the Hampi ruins and named after it with two 9,000 kW units initially to be followed by one more unit and a further unit (4th unit) under the second stage.

(*c*) A power transmission grid connecting the power houses with the consuming centres in the Bellary, Anantapur, Kurnool, Cuddapah and Nellore Districts.

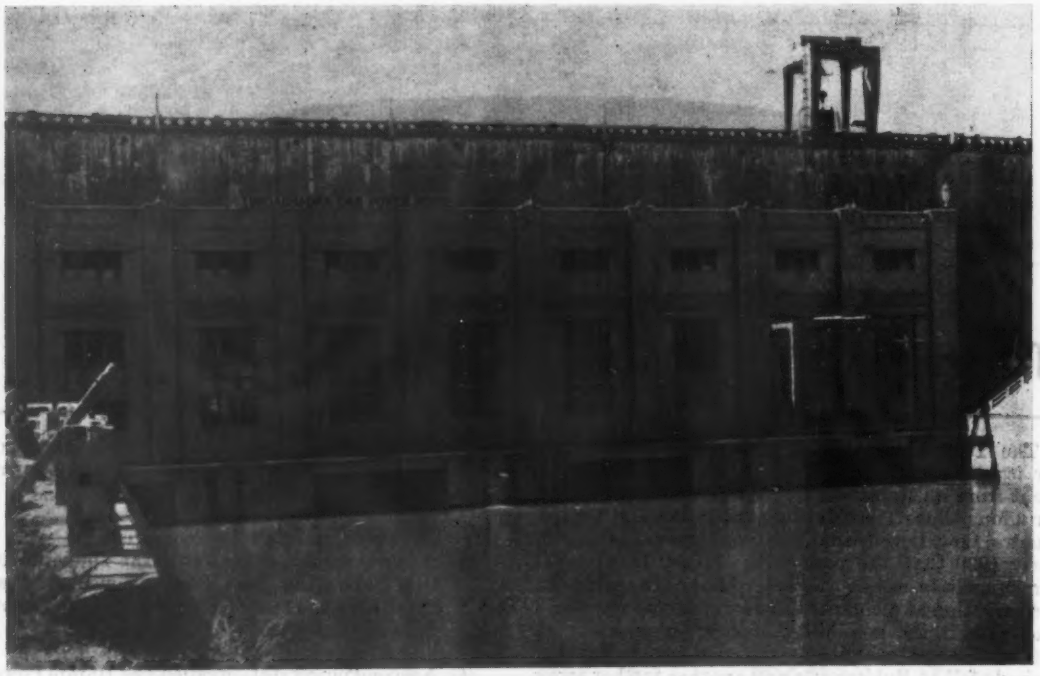
Tungabhadra Hydro Electric Scheme is the second hydro electric scheme of the erstwhile Andhra State and the fifth hydro electric station in Mysore. Power from this station is now being supplied to Bellary, Chintaldrug and Dharwar districts of Mysore State and a vast area of Rayalaseema in Andhra Pradesh, which, though rich in resources, is backward in development, mainly because of lack of cheap and abundant electric power.

The Dam Power House constructed at the foot of the Tungabhadra Dam, is about 3 miles from Hospet in Bellary District. There is a good motorable road from Hospet to the Dam site. Hospet is on the railway line between Guntakal and Hubli, and access is by a good motorable road, 12 miles in length from Hospet. A map showing access to site is given.

Civil Engineering Works

The Tungabhadra Dam is primarily intended for storing water for irrigation. The gross head available at the Dam Power House varies from 43 ft. to 95 ft. This head is utilised for power generation at the Dam Power House.

Water for irrigation is drawn through canals on both flanks of the Dam. The low level canal on the



Dam Power House : Tailrace Pond after water is let in.

right flank through which water is drawn for irrigation purposes by both Andhra and Mysore states carries a maximum discharge of about 2500 cusecs during the irrigation period. At about the 14th mile of canal, a drop in ground level of about 110 ft. occurs and this head is also utilised for power generation.

Thus the water mainly intended for irrigatoin is made use of for generation of power at two different points prior to its being utilised for irrigation.

Dam Power Station

Power Potential

The firm power available from the minimum discharge at the Dam will be about 12,500 kW at 60% L.F. The seasonal power, however, with about 2500 cusecs maximum discharge may be as high as 26,500 kW.

Hydro Electric Pipes and Intake

Four steel pipes of 11′-0″ dia. and 1/2″ shell thickness are installed in the dam with intakes and head gate controls. Only two of them are utilised initially, the other two having been left closed with blank flanges.

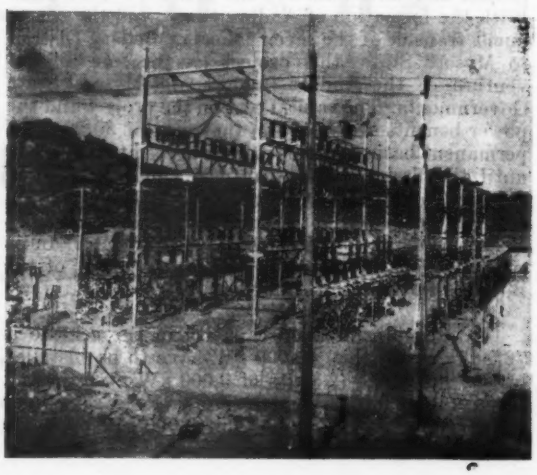
Supply of water to the turbine is further controlled by 11′-0″ dia. electrically operated butterfly valves located immediately above the power station.

Turbines and Generating Machinery

The two vertical shaft, Kaplan turbines each of maximum output capacity of 13,800 H.P., at 214 R.P.M. now installed are manufactured in Switzerland. These are coupled to two 9000 kW 3 phase 50 cycles 11 kV alternators, also manufactured by M/s Brown Boveri in Switzerland. The indoor switchgear is also supplied by Swiss manufacturers.

Transformer Yard with kiosks Dam Power House

Outdoor Transformer Yard—Hampi Power House.



Concreting for the first Penstock at the Canal Power House

Power House Buildings

The power house building is designed to accommodate all the four units, though only two units are installed initially.

The foundation of the machines and the stanchions supporting the superstructure, gantry and crane are taken down to hard rock. The power house superstructure is of R.C.C., on account of the shortage of steel, and in keeping with the general appearance of the Dam. The electrically operated overhead travelling crane for handling heavy lifts is of 75 ton capacity.

Transformer Yard

This is located adjacent to the power house at right angles to its longer axis. To avoid extensive excavation for the yard, the equipments are arranged at different levels. The transformers are kept at the Power House floor levels and the other structures at higher levels to suit the general ground formation.

Two transformers of capacity 10.6 mVA each are installed to step-up the generated voltage from 11 kV to 66 kV. for transmission to distant centres.

The lines taking off at the Dam station are as follows:

66 kV single circuit line to Bellary (constructed under the Ceded district scheme).

66 kV double circuit lines to Hampi Power House.

66 kV single circuit line to Sokke. (constructed under the ceded district scheme).

Two 1500 kVA 66/11 kV step-down transformers have been provided for giving 11 kV supply for local services and emergency stand-by auxiliary supply to Hampi Power House.

The outdoor switchgear such as circuit breakers, isolators etc., are from Switzerland. The breakers are of the minimum-oil-content type.

The 66 and 11 kV structures are of galvanised steel.

The names of the plant manufacturers and contractors connected with this scheme are furnished in Annexure II.

Station Auxiliaries

Power for station auxiliaries are supplied from two unit transformers of capacity 500 kVA 11kV/400 volts each connected to the alternator terminals.

A house set comprising 375 kVA 3 phase 50 cycles 400 volts generator coupled to a 680 B.H.P. Francis turbine is provided for alternative feed to the station auxiliaries in case of failure of supply from the main generating sets.

Hampi Power Station

The Head Works

When the power canal carries a discharge of about 2500 cusecs the maximum seasonal power that could be developed will be about 31,800 kW at 60% load factor at a net head of 110 ft at the Hampi station. But in summer when there is restricted irrigation flow the power that could be generated will be only about 19,500 kW at 60% load factor. During the earlier stages of irrigation it may be possible to draw higher firm power by regulating the discharges from the reservoir more evenly.

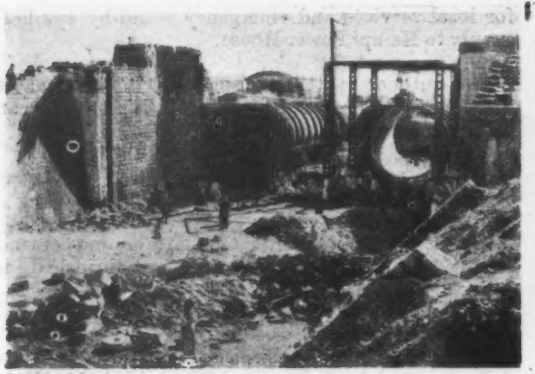
The total firm power potential of dam and canal power houses is about 32,000 kW and the total seasonal power potential at the two stations is about 58,300 kW.

The forebay for Hampi station has a useful capacity of 28 mc. ft. The purpose of the forebay is to store the canal discharge during non-peak hours and admit this during the peak load period. The forebay is located at the end of the power canal and in the south-east corner of the famous Hampi ruins. In view of the historical importance of the ruins, the site for the forebay has been fixed in consultation with the Archeological Department of the Government of India so as to cause least damage to the monuments in the area.

The forebay is formed by a composite dam with earth backing and an earthen bund with clay puddle hearting and gravel casing. As rock is not available at reasonable depth for foundations in this area, a masonry dam could not be built. However the portion of the bund where the pipe intakes are located is in masonry, founded on rock.

Low Pressure pipe lines

Out of the two low pressure steel pipe lines 18'-0" in diameter each capable of discharging 2200 cusecs proposed for peak load conditions, only one pipe is installed initially. The intake structures for both the pipes together with the gates, hoists and trash racks



Entrance of Low Pressure Pipe line of canal Power House at Intake Structure

are however constructed even at this stage. The second pipe will be blank flanged at the downstream end.

Surge Tank

Each of the two low pressure pipe lines end in a differential surge tank of steel. Only one surge tank is being constructed initially. The second low pressure pipe line including the second surge tank will be installed later.

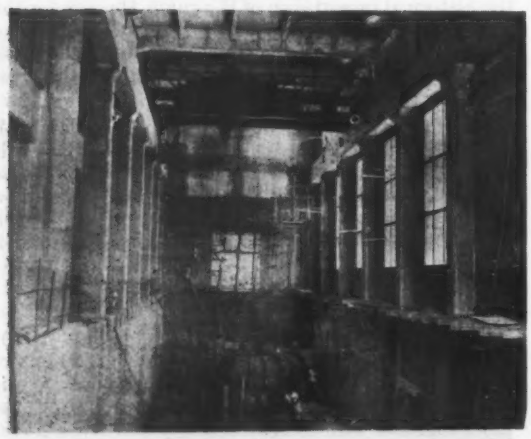
Penstocks

Four steel penstocks, two from each surge tower will be provided ultimately, but only two are being installed during the initial stage. Grading for all the pipe lines will be done initially.

Each pipe will be 12′-0″ in diameter capable of supplying a maximum discharge of 1100 cusecs for peak load requirements. Each of these penstocks will be connected independently to a turbine in the power house.

Each penstock will be provided with one set of butterfly valve, air valve at the surge tank and another set of butterfly valve, pressure recorder, and venturimeter at the power house end.

Erection of first unit in progress Canal Power House



Intake structure at the head of L.P.P.L. of Canal P.H.

Power House Building

The power house is located in a cutting and is 200 ft. long and 60 ft. wide for accommodating the eventual installation of four generating units. Only two units are now installed. The power house sub-structure is of R.C.C. as in the case of Dam Power House.

Turbine and Generating Machinery

The two vertical shaft, Francis turbines, each of maximum capacity 12,600 H.P., 214 R.P.M. erected, are of Swiss make. These are coupled to two 3 phase 50 cycles 11 kV 9000 kW alternators, also manufactured in Switzerland.

The indoor switchgear is also of Swiss origin.

Tail Race

The tail race level is fixed to suit the level of the low level canal which is fed by the tail race.

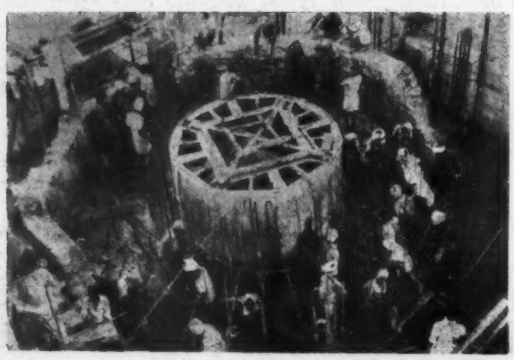
Transformer Yard

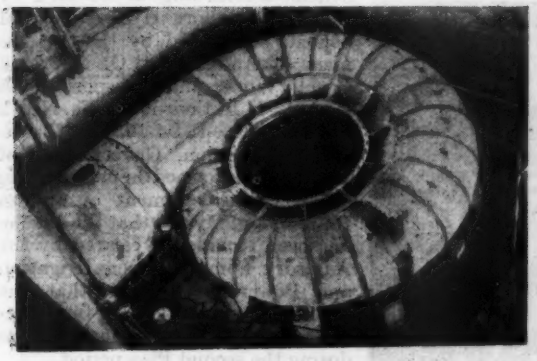
This is of outdoor type and is located at right angles to the Power Station. Excavation for the yard is in benching as at the Dam Power House.

Two transformers of capacity 10·6 mVA similar to those at Dam Power House are installed.

The following 66 kV line take-offs have been provided at Hampi Power Stations :

Turbine No. 1. Work in progress at the Canal P.H.





Spiral casing of Second Unit of the Canal P.H.

1. 66 kV double circuit inter-connectors to dam power station.
2. 66 kV feeder to Bellary with space provision for a second feeder to Bellary.

Station Auxiliaries

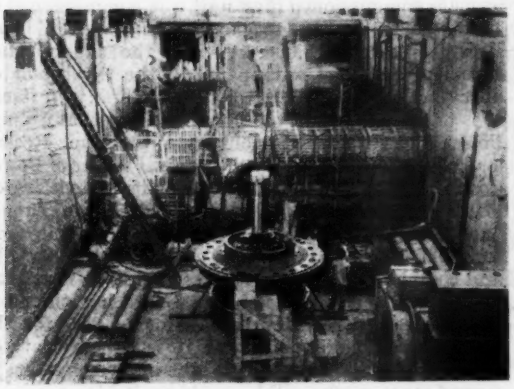
Power for station auxiliaries will be supplied from two unit transformers of capacity 500 kVA 11kV/400 volts each connected to alternator terminals.

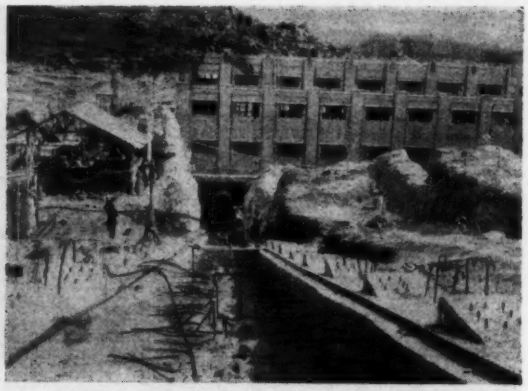
There will be an additional 500 kVA 11kV/400 volts out-door station transformer fed by the 11 kV Dam-Hampi feeder to provide alternative feed to the Station auxilaries in case of failure of supply from the main generating sets.

Transmission System

There will be around 600 circuit miles of 66 kV main transmission lines and 110 circuit miles of 33 kV sub-transmission lines located in the Tungabhadra Scheme area of Andhra Pradesh and extend from Bellary to as far as Renigunta where they will meet the transmission lines under the Nellore Thermal Scheme. The transmission system also comprises the subsations at Bellary, Guntakal Gooty, Kurnool, Cuddapah and Renigunta. The Mysore transmission system reaches as far as Davangere so as to link up the Tungabhadra system with the Mysore system, and comprises substations at Bellary, Sokke, Kudligi Tornagallu etc. Annexure III gives the details of transmission lines.

General view of I and II Units of the Canal P.H.





Work on first penstock in progress in the Canal P.H.

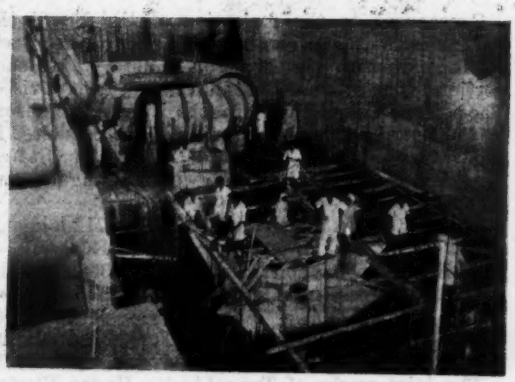
Sub-Stations

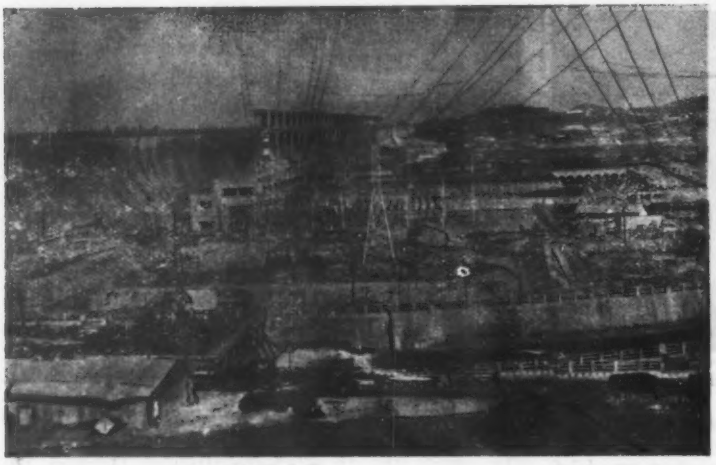
The 66 kV main sub-stations provided in the scheme are given below along with installed transformer capacities.

Name of the substation.	*Number and capacity of transformers.*
Sokke	2 Nos. 250 kVA.
Kudligi	3 Nos. 500 kVA.
Tonnagallu	1 No. 1000 kVA.
Bellary	2 Nos. 1000 kVA and 2 Nos. 3000 kVA.
Guntakal	2 Nos. 1000 kVA.
Gooty	3 Nos. 3000 kVA and 1 No. 1500 kVA.
Dhone	3 Nos. 1500 kVA.
Kurnool	3 Nos. 3000 kVA.
Tadapatri	2 Nos. 1000 kVA.
Erraguntala	2 Nos. 1000 kVA.
Cuddapah	3 Nos. 1500 kVA.
Rajampet	2 Nos. 500 kVA.
Kodur	2 Nos. 500 kVA.
Anantapur	2 Nos. 1000 kVA.
Dharmavaram	3 Nos. 100 kVA.
Penukonda	1 No. 500 kVA and 1 No. 250 kVA.
Hindupur	2 Nos. 1000 kVA.

There are two 3000 kVA synchronous condencers,

Turbine work in progress at the Canal Power House





Dam Power House and Transformer Yard.

one at Gooty and one at Renigunta for voltage regulation and stabilisation of the Andhra Transmission System.

Agency of Execution

Prior to the formation of the Andhra State on 1-10-1953, the entire scheme including the irrigation part of it was executed by the Public Works Department and Electricity Department of the composite State of Madras. Similarly, works on the Hyderabad side were executed by the State Government of Hyderabad. Subsequent to the formation of the Andhra State and the consequent change due to a portion of the Bellary district, comprising the seven taluks where the dam and the two appurtenant works are situated, having been transferred to the Mysore State, the Tungabhadra Board was formed by the Government of India, as stated earlier.

The constitution of the Tungabhadra Board is furnished in annexure I.

The Board has the powers of the State Government and will execute all the common works connected with the scheme on the right bank including the regulation of water and power.

Capital Costs

The scheme as originally estimated is to cost about Rs. 7.3 crores initially, rising to about Rs. 8 crores at the end of ten years.

Consequent to the formation of the Board the scheme estimates had to be split up into three parts corresponding to the Mysore, Andhra and Board portions. The estimates also have since been revised. The power developed as well as the capital expenditure on the Board portion of the scheme is to be shared in the ratio of 80:20 by Andhra and Mysore States. The details of the break-up estimate figures are furnished below :

Common works under the Board.	Rs. 712 lakhs (Revised)
Andhra Transmission lines etc.	Rs. 363.47 lakhs.
Mysore Transmission lines etc.	Rs. 32 lakhs.

Second Stage Development of the Tungabhadra Hydro Electric Scheme

The joint works of Tungabhadra Hydro Electric Scheme second stage are covered by the T.B. Nellore Hydro Thermal Scheme sanctioned by the Government of Andhra in G.O. No. 2142 (Public Works and Transport) dated 27-7-1956. In their letter No. NR. 2 (4)/57 (A) dated 24-4-1957 the Planning Commission, Government of India, have informed the participating states viz. Government of Andhra Pradesh and Mysore that the scheme has been technically cleared by the Advisory Committee on Irrigation and Power Projects and that the scheme may be taken up for implementation by the two Governments during the second Plan period.

The Tungabhadra Hydro Electric Scheme covered by the above sanctions provides for the following works to be executed under the control of the Tungabhadra Board.

(*i*) Installation of the fourth generating unit (9000 kW capacity) at Hampi Power House.

(*ii*) third & fourth units (9000 kW capacity) each at Dam Power House to complete the full development of the two Tungabhadra Power Stations.

(When these sets are installed it will be possible to obtain seasonal power to the extent of about 58.3 mW from the two stations, the firm power being about 32 mW)

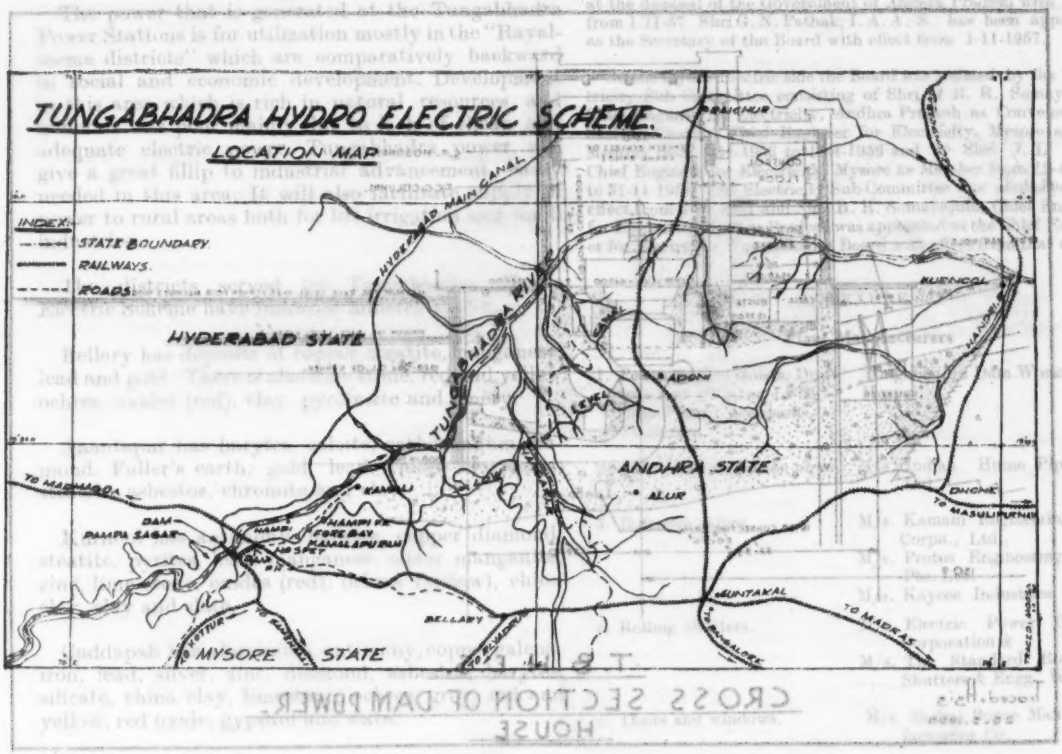
(*iii*) Erection of the second 66 kV circuit from Hampi Power House to Bellary Sub-station.

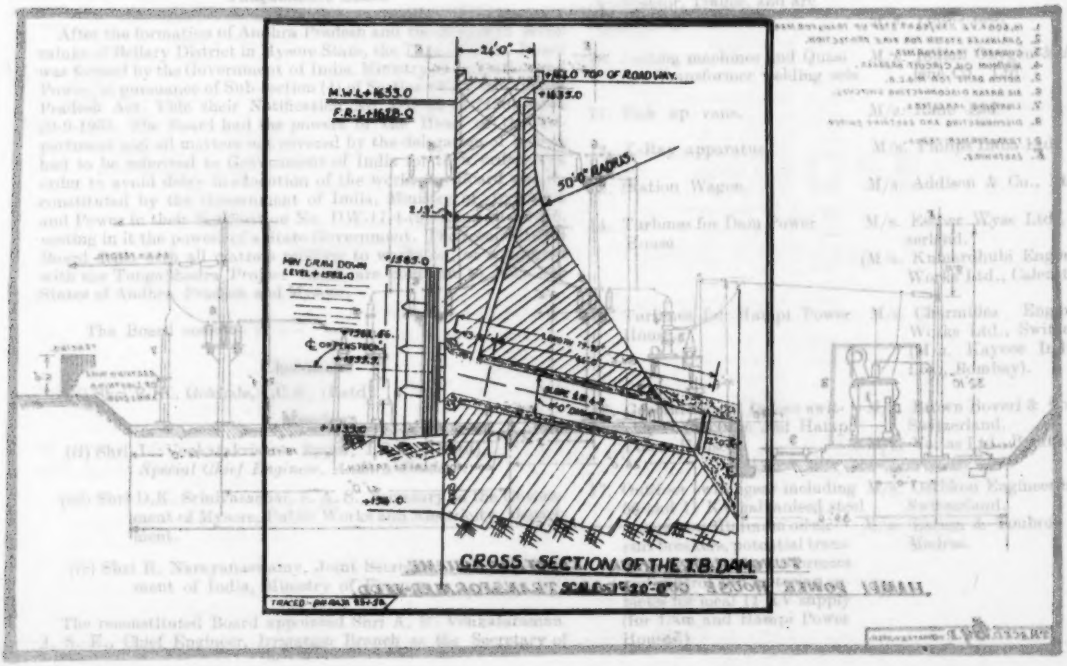
The above works are expected to be taken up during the year 1958-1959 and completed by the year 1960-61.

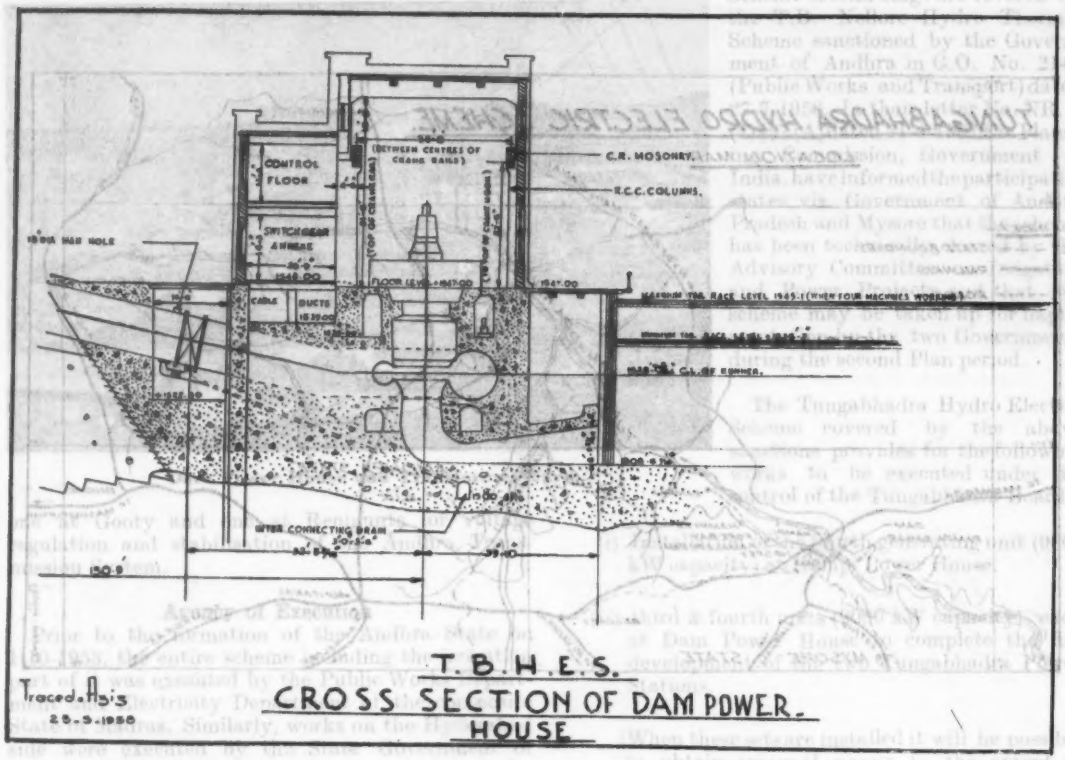
It is proposed to call for tenders for the supply and erection of the generating units at both Dam and Hampi Power House very soon.

Load Prospects

It is gratifying to note that the load forecast envisaged in the sanctioned Tungabhadra Hydro Electric Scheme is being realised at a more rapid rate. The demand on the Tungabhadra Dam Power House which is commissioned (first unit was commissioned in January 1957 and the second unit in May 1957) has already reached 18,000 kW i.e., the present full capacity. The load anticipated in the third year of operation has actually reached in the first year itself. It is anticipated that the power generated at Hampi Power House also will be consumed very soon. Recent load survey carried out by the Central Water & Power Commission indicated that there will be an accelarated load development in the area served by the Tungabhadra Hydro Electric Scheme. Under the circumstances it is necessary to take up second stage works and complete them during the second Five Year Plan period itself. The Tungabhadra Board has therefore rightly decided recently to call for tenders for the second stage equipment and it is hoped that the necessary foreign exchange for the implementation of second stage works will be made available.


TUNGABHADRA HYDRO ELECTRIC SCHEME.
LOCATION MAP
INDEX:-
STATE BOUNDARY.
RAILWAYS.
ROADS.
HYDERABAD STATE
ANDHRA STATE
MYSORE STATE
HYDERABAD MAIN CANAL
TUNGABHADRA RIVER
RAICHUR
KURNOOL
ADONI
ALUR
KAMALI
HAMPI
PAMPA SAGAR
DAM
HAMPI RE-FORE BAY
KAMALAPURAM
GUNTAKAL
BELLARY
TO MADRAS
TO MASULIPATNAM
TO BANGALORE
TO KOTTUR
TO RAYADRUG
TO BELLARY
TO MADHAVA

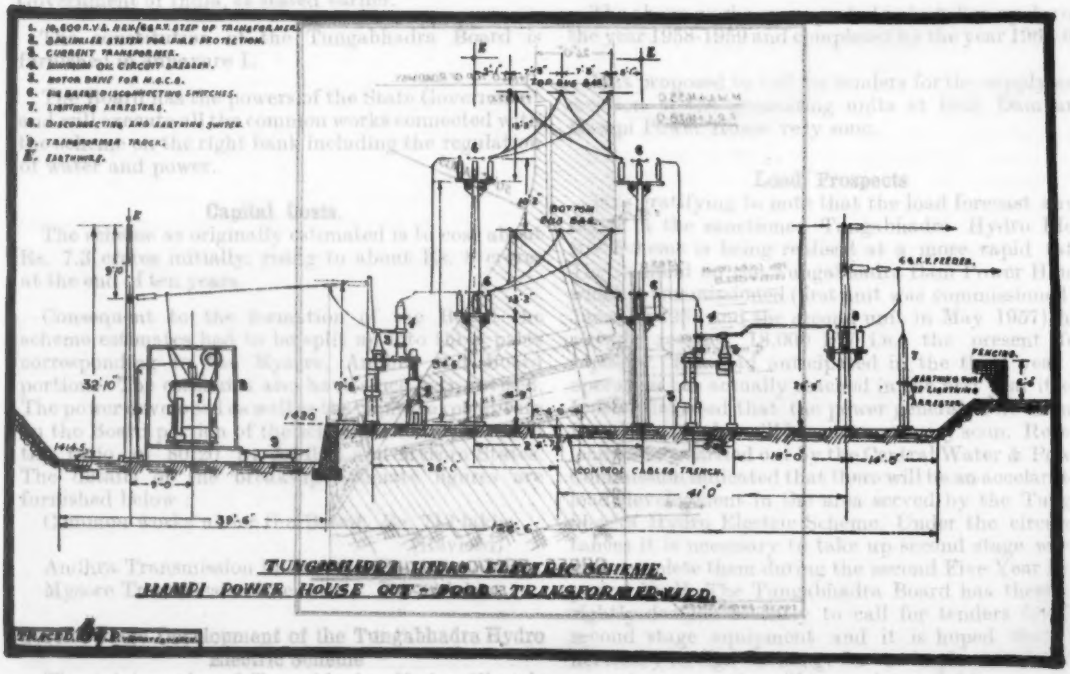

CROSS SECTION OF THE T.B. DAM.
SCALE:- 1"=20'-0"
M.W.L.+1633.0
F.R.L.+1628.0
+1633.0 TOP OF ROADWAY.
50'-0" RADIUS.
26'-0"



T.B.H.E.S.

CROSS SECTION OF DAM POWER HOUSE

Traced. A.J.S
28-9-1956



TUNGABHADRA HYDRO ELECTRIC SCHEME.

HAMPI POWER HOUSE OUT-DOOR TRANSFORMER-YARD.

Conclusion

The power that is generated at the Tungabhadra Power Stations is for utilization mostly in the "Rayalseema districts" which are comparatively backward in social and economic development. Development in this area which is rich in natural resources and minerals was poor mainly due to lack of cheap and adequate electric power. Tungabhadra power will give a great fillip to industrial advancement badly needed in this area. It will also facilitate supply of power to rural areas both for lift irrigation and small industries.

The districts served by Tungabhadra Hydro Electric Scheme have immense mineral wealth.

Bellary has deposits of copper, steatite, manganese, lead and gold. There is also lime stone, red and yellow ochres, oxides (red), clay, pyrolusite and emery.

Anantapur has barytes, calcite, carborundum diamond, Fuller's earth, gold, lead, yellow ecyquartz, steatite, asbestos, chromite and clay.

Kurnool has antimony, barytes, copper diamond, steatite, pyrites, lead, manganese, silver manganite, zinc, lime stone, oxides (red), ochres (yellow), china clay, clay and slate.

Cuddapah has aluminium, antimony, copper galena, iron, lead, silver, zinc, diamond, asbestos, barytes, silicate, china clay, limestone, ochres, grey, red and yellow, red oxide, gypsum and slate.

With the advent of adequate hydro power from the Tungabhadra Power Stations it will be possible to explore the above mineral wealth in the near future.

ANNEXURE—I

Tungabhadra Board

After the formation of Andhra Pradesh and the merger of seven taluks of Bellary District in Mysore State, the Tungabhadra Board was formed by the Government of India, Ministry of Irrigation and Power, in pursuance of Sub-section (4) of Section 66 for the Andhra Pradesh Act. Vide their Notification No. DW-II-22 (129) dated 29-9-1953. The Board had the powers of the Head of the Department and all matters not covered by the delegation of powers had to be referrred to Government of India for their orders. In order to avoid delay in execution of the work, the Board was reconstituted by the Government of India, Ministry of Irrigation and Power in their Notification No. DW-11-4-(9) dated 10-3-1955, vesting in it the powers of a State Government. The reconstituted Board deals with all matters relating to works on, or connected with the Tungabhadra Project which are common to both the States of Andhra Pradesh and Mysore.

The Board consists of :—

Chairman

(*i*) Shri B. K. Gokhale, I.C.S., (Retd).

Members

(*ii*) Shri L. Venkatakrishna Ayyar, I.S.E., (Retd), *Special Chief Engineer, Andhra Pradesh.*

(*iii*) Shri D.K. Srinivasachar, I. A. S., Secretary to the Government of Mysore, Public Works and Electricity Department.

(*iv*) Shri R. Narayanaswamy, Joint Secretary to the Government of India, Ministry of Finance.

The reconstituted Board appointed Shri A. R. Venkataraman, I. S. E., Chief Engineer, Irrigation Branch as the Secretary of the Board. The services of Shri A. R. Venkataraman were replaced at the disposal of the Government of Andhra Pradesh with effect from 1-11-57. Shri G. N. Pathak, I. A. A. S., has been appointed as the Secretary of the Board with effect from 1-11-1957.

On the Hydro Electric side the Board was assisted by the Electricity Sub Committee consisting of Shri of B. R. Somayajulu, Chief Engineer for Electricity, Andhra Pradesh as Convener and Shri G. Chandy, Chief Engineer for Electricity, Mysore as the Member from 1-11-1953 to 18-4-1956 and by Shri J. L. D'sa, Chief Engineer for Electricity, Mysore as Member from 19-4-1956 to 31-11-1957. The Electricity Sub Committee was abolished with effect from 1-11-1957 and Shri B. R. Somayajulu, Chief Engineer for Electricity, Andhra Pradesh was appointed as the Chief Engineer for Electricity, Tungabhadra Board with effect from that date.

ANNEXURE II

Plant Manufacturers

1. Penstock gate Hoists, Draft tube, cut off gates, LPPL surge tank, penstocks, Trash rack.	Tungabhadra Dam Workshops, Hospet.
2. 11-0″ dia. Extension pipes.	M/s. Indian Hume Pipe Co. Ltd.
3. Butterfly valves.	M/s. Kamani Engineering Corpn., Ltd., M/s. Protos Engineering Co., Pte. Ltd. M/s. Kaycee Industries Ltd.,
4. Rolling shutters.	M/s. Electric Power Devices Corporation & M/s. The Standard Rolling Shutters & Engg. Works.
5. Doors and windows.	M/s. Godrej Boyce Manufacturing Co.
6. 75 ton Electrically operated Travelling cranes.	M/s. K. G. Khosla & Co.
7. R. B. Excavators.	M/s. Greaves, Cotton & Co. Ltd.
8. FD Rear dumpers.	M/s. Blackwood Hodge (I) Pte. Ltd.
9. Tractor, Trailor, and arc welding sets.	M/s. Voltas Ltd.
10. Cutting machines and Quasi Arc Transformer welding sets	M/s. Indian Oxygen & Acetylene Co., Ltd.
11. Pick up vans.	M/s. Rane Ltd.
12. X-Ray apparatus.	M/s. Philips India Ltd.
13. Station Wagon.	M/s. Addison & Co., Ltd.
14. Turbines for Dam Power House	M/s. Escher Wyss Ltd., Switzerland. (M/s. Kumardhubi Engineering Works Ltd., Calcutta.)
15. Turbines for Hampi Power House.	M/s. Charmilles Engineering Works Ltd., Switzerland. (M/s. Kaycee Industries Ltd., Bombay).
16. Generators and Indoor switchgear for Dam and Hampi Power Houses,	M/s. Brown Boveri & Co. Ltd., Switzerland. M/s. Voltas Ltd., Bombay.
17. Outdoor switchgear including 66 and 11 KV galvanised steel structures, Minimum oil circuit breakers, potential transformers, current transformers and control and metering cubicles for local 11 KV supply (for Dam and Hampi Power Houses.)	M/s. Oerlikon Engineering Co., Switzerland. M/s. Larsen & Toubro Ltd., Madras.

18. Power Transformers for Dam and Hampi Power Houses.	M/s. English Electric Co., Ltd., England. (M/s. Binny & Co., Ltd., Madras). M/s. Siemens Schuckert Werke, Germany. M/s. Protos Engineering Co. Pte. Ltd., Madras.
19. Power cables.	M/s. Johnson & Philips Ltd., England. (M/s. Johnson & Philips Ltd., Bombay). M/s. Aberdare Cables Ltd., Aberdare, England. (M/s. Steam & Mining Equipment (India) Ltd., Calcutta.)
20. Control cables.	M/s. Brown Boveri & Co. Ltd., Switzerland. (M/s. Voltas Ltd., Madras.) M/s. William Giepel & Sons, England. (M/s Gordon, Woodroffe, Madras.)
21. Lighting Installation.	
22. Transmission lines.	M/s. Crompton Engineering Co. (Madras) Private Ltd., Madras. M/s. Jessop & Co., Ltd., Calcutta. M/s. Aluminium Wire and Cable Co., Ltd., England. M/s. Nippon Gaishi Kaisha Ltd., Japan. (M/s. Kamani Engineering Corporation Ltd.) M/s. National Insulated Cable Co., Calcutta. (M/s. P. Natesan & Co., Madras). M/s. W. T. Henley's Telegraph Works Co. Ltd., Calcutta. M/s. Richardson & Cruddas Ltd., Bombay. M/s. Bullers Ltd., England. M/s. Kokoku Iron and Steel Manufacturing Co., Ltd., Japan. (M/s. Modi & Modi Co., Bombay.) M/s. Electrical Machines Corporation Pte. Ltd.,Calcutta. M/s. Aluminium Industries Ltd., Kundara.
23. Substations.	M/s. Westinghouse, U.S.A. M/s. Cromptons, U.K. M/s. S & E, U.K. (M/s. Crompton Engineering Co. Ltd., Madras.) M/s. Magrini, Italy. M/s. Line Equipment Ltd., U.K. M/s. Hackbridge & Hewittic Electric Co., Ltd., U.K. M/s. Hugh J. Scott, U.K. Legg Industries Ltd., (M/s. Easun Engineering Co., Ltd., Madras.) M/s. S.E.M. Co., Belgium. M/s. International General Electric Co., (India) Ltd., Madras. M/s. Asea Electric Co., Sweden (M/s. Asea Electric Co., (India) Ltd., Bombay.) M/s. Tudor Accumulator Co., Ltd., U.K. (M/s. Dodsal Pte. Ltd., Bombay.) M/s. British Thompson Houston, U.K. (M/s. Associated Electrical Industries (I) Pte. Ltd., Madras.) M/s. Cooke & Ferguson, U.K. (M/s. Greaves, Cotton & Crompton Parkinson Ltd., Madras.)
24. Synchronous condenser at Gooty substation.	M/s. Oerlikon Engineering Co., Switzerland. M/s. Larsen & Toubro Ltd., Madras.

ANNEXURE III

Tungabhadra Hydro Electric Scheme (Andhra Portion)

Transmission Lines

I. 66 kV lines

Name of the line	*Length in Miles*	*Power conductor*	*Equivalent in sq. inches*
A. *Tower Lines* :			
1. Bellary—Guntakal S. C. line.	30	7/0.161″ACSR	0.075
2. Guntakal—Gooty D.C. line	18	7/0.161″ACSR 7/0.161″ACSR	0.075
3. Gooty—Guddapah L.C. line	98	7/0.144″ACSR	0.060
4. Gooty—Kurnool L.C. line	55	7/0.161″ACSR	0.075
B. *Light Construction* :			
5. Cuddapah-Kodur L.C.	54	7/0.144″ACSR	0.060
6. Kodur-Renigunta L.C. Line	27	7/0.144″ACSR	0.060
7. Gooty-Anantapur L.C. line	32	7/0.102″ACSR	0.030
8. Anantapur-Dharmavaram S.C. line	20	7/0.102″ACSR	0.030
9. Dharavaram-Penukonda S.C. line	28	7/0.102″ACSR	0.030
10. Penukonda-Hindupur S.C. line	23	7/0.102″ACSR	0.030

ANNEXURE IV

Project at a Glance

I. *General* :	
1. Name or river to be harnessed.	Tungabhadra River.
2. Catchment area of the river.	10,880 sq. miles.
3. Maximum flood discharge.	3,30,000 Cusecs.
4. Reservoir water spread.	133 sq. miles.
5. Total capacity of the reservoir.	1,13,126 Million Cubic feet.
6. Maximum length of Reservoir.	100 miles.
7. Type of Dam.	Straight Gravity type Masonry construction.
8. Height from the deepest foundation.	160 feet.
9. Length (including spillway).	About 8,000 ft.
10. Width of road way on top of dam.	22 feet.
11. Bottom width at deepest foundation.	93.5 feet.
II. *Dam Power House* :	
1. Length.	275 feet.
2. Width.	63 feet.
3. Height.	About 50 ft. above generator floor level.
4. Gross head.	43′ to 96′.
5. No. of Power units.	2 Nos. 9000 kW each ordered for the initial stage and 4 Nos. ultimately.
6. Power generated (1st Stage)	18,000 Kilo Watts.
7. Power Canal length.	13 miles 3 furlongs.
8. Power Canal capacity	2600 cusecs
9. Power Canal Bed width.	72 feet.
10. Power Canal Bed width at Flumes.	21 feet.
11. Power Canal velocity.	About 3 feet.

Continued on page 50

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COLOMBO

Upper Sileru Hydro-Electric Project : 1st stage

The Upper Sileru Hydro-Electric Project is a sequel to the 110,000 kW. Machkund Hydro Electric Project, the second and final stage of which is currently under execution in the upper reaches of the same river. The project envisages further regulation of the flow of the Sileru river by construction of about 180 ft nigh dam at Guntavada and utilisation of a total average head of about 425 ft. by bye-passing a "U" bend of the river below Guntavada village. A net power draft of the order of 4,150 cusecs, including a discharge of 1,400 cusecs from the Machkund power house is expected for the Upper Sileru scheme, which, on full development, will increase the firm power potential of the combined Machkund-Upper Sileru system to about 368,000 kW at 60 per cent load factor. After the river flow is thus regulated, the waters of the Sileru can be utilised again at a further total drop of about 800 ft. along the course of the Lower Sileru, constituting additional power potential of the order of 400,000 kW at 60 per cent load factor.

The Characteristics of the River

The Sileru River which rises at a general altitude of +5,000 ft. drains the western face of the Eastern Ghats known as Machkund in its uppermost reaches, it flows in a north westerly direction upto Chikanput and then joins with Sabari, an important tributary of the Godavari River. The average rainfall in the basin, which is a hilly region, is of the order of 54 inches. The table below indicates the maximum heads existing and the proposed schemes in the Sileru basin :

Jalaput Dam	135 feet
Machkund	850 "
Guntavada Dam	140 "
Upper Sileru P.H.	320 "
Lower Sileru P.H.	800 "
	2,245 feet

Silt in the River

Observations for the Machkund Project indicated that the annual inflow of silt from the 858 sq miles catchment is 35 m.c. ft. on an average. In this area the soil is soft and easily erodable. Another cause of silting is the practice of "Podu" or shifting cultivation. Consequently a large portion of the catchment is subjected to erosion. Soil Conservation measures are on hand in the Machkund basin on a large scale. These may be extended to other areas as well.

Life of the Reservoir

According to the Member, Central Water & Power Commission, the Jalaput reservoir has a life of about 100 years providing a dead storage of about 2750 m.c.ft. The intermediate catchment of the Sileru below the Machkund diversion weir comprises largely of dense forest and the slopes are gentler. Therefore, the silting problem for the Guntavada Reservoir is not expected to be very severe. The dead storage of 3400 m. c. ft available at +1410 ft would be adequate and should assure a life of well over 400 years. In any case the works proposed for the 1st stage are free from the silt problem.

Rainfall

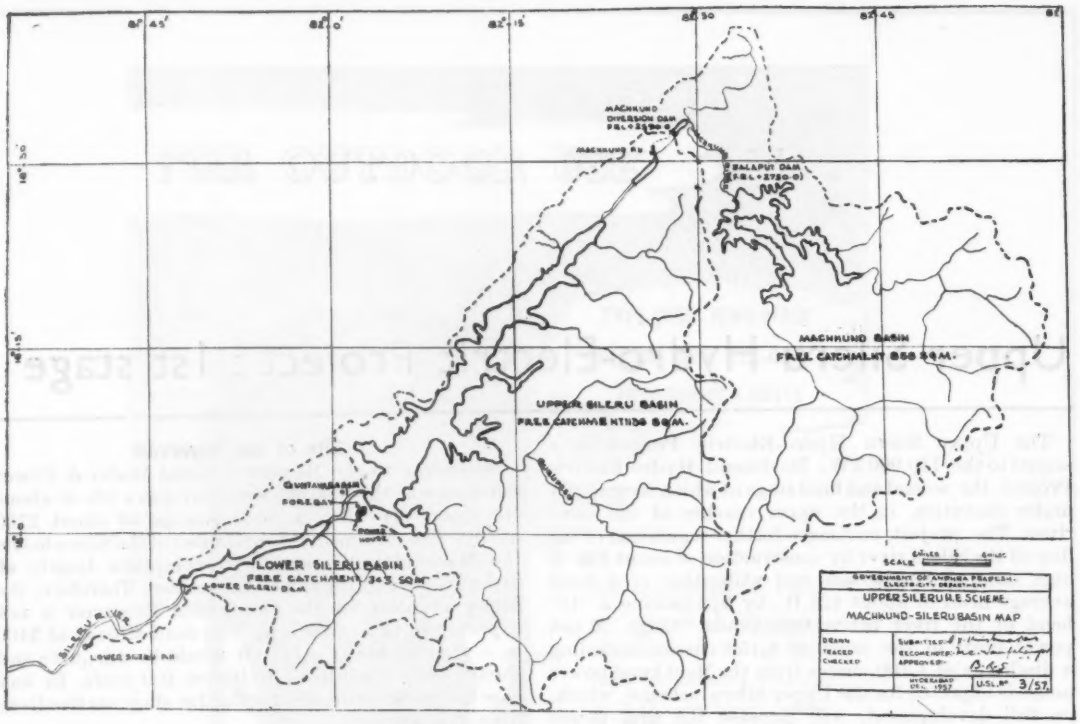
The total catchment of the Guntavada Dam site is 1,994 sq miles. In the Machkund Basin rainfall records are available from 1942 at Jalaput and from 1947 at the diversion dam site. In the free catchment area there is a station at Chintapalli (1942-54) due to the inadequacy of rainfall data the average rainfall for the free basin of 1136 sq miles has been calculated by the Theisson Polygon method, as 54.64" as against 54.465" for the intercepted catchment of the Machkund Basin. Fifteen new stations are being installed.

Run-off

Similarly the run off rainfall ratio of 46% for the Kolaba Basin has been calculated due to to meagre data. The ratio for the Machkund Basin was about 60%. The ratio for the free catchment of 1136 sq miles below Machkund Dam has been completed on the basis of the Machkund catchment data as no direct data were available and as the catchments are very similar in character except for the difference in elevation of 1000 ft.

Flood Studies

There is no record of the maximum flood at the Guntavada Dam site, which has, therefore, to be calculated from guaged flows at the Machkund diversion weir. The maximum flood at the Guntavada site thus works out to 280,000 but due to the construction of the Jalaput reservoir the maximum flood discharge at the weir site will be 53,000 cusecs which will be further moderated at the Guntavada site to 45,000 for discharging the spillway capacity of the Guntavada. In the 1st stage a maximum flood discharge of 250,000 cusecs has been adopted.



Machkund-Sileru Basin Map

Power Potential

Power potential studies for the ultimate stage at Upper Sileru are based on computed stream flow. But the lst stage of the project is based largely on releases on the Machkund Scheme for which sufficient guaged data is available.

At Upper Sileru the waters available for power generation are :

(*a*) the regulated releases of 1,400 cusecs continuous from Machkund power station
(*b*) the surplusses from the Machkund catchment, and
(*c*) the free flows from the catchment of 1,136 sq miles between Machkund weir and Guntavada.

It has been estimated that with an effective storage of the order of about 1,200 m. cft. an additional discharge of 400 cusecs can be made available for the Sileru schome from the intermediate catchment. The minimum power draft for the Upper Sileru scheme would thus be about 1,800 cusecs. During the rest of the year (i.e. from June to February) the discharges would naturally be much higher.

The minimum continuous power potentials at Machkund (844 ft. net head) and Upper Sileru (310 ft. net head) based on their absolute minimum power drafts of 1,400 cusecs and 1,800 cusecs respectively are 84.4 m.W. and 41.0 m.W. at 100% load factor making a total of 125.4 m.W. The more exacting water requirements based on the Madras System have been taken as basis for planning. If the load factor continues to be as low as at present. The effective capacity of the Machkund-Upper Sileru system will be about 230 m.W. in the proposed installation. Thus the additional firm system capacity, on completion of lst stage of the Sileru Scheme, would be 100 m.W. The proposed plant capacity of 120 m.W. would suffice for co-ordinated operation.

The Project

The dam site is near Guntavada village longitude 82°-01′ and latitude 18°-03′. The approach is from Narsipatnam Road railway station (via.) Chintapalli—Gudem—Dharakonda to Sileru, the total distance being about 90 miles. The nearest port is Visakhapatnam. Chintapalli is the taluk head quarters in the Narsipatnam sub-division of the Visakhapatnam district and is 50 miles from the Narsipatnam railway station on the Bezwada—Waltair section of the Southern Railway. A good motorable road exists and regular motor transport facilities are available upto Chintapalli. From Chintapalli to Gudem, a distance of about 12 miles, a motorable road exists and vehicular traffic is possible during fair weather. The reach from Gudem to Dharakonda and thence to the site is connected only by a foot path. For purposes of investigation, a jeepable approach has been made over the hilly terrain. An alternative approach to the project site from Narsipatnam via. Lothugudda is being investigated. Also a jeepable road from the Machkund diversion dam is being considered. However for the construction of the Sileru Project, a pucca road has to be formed to the project site and work on this has already been taken up by the Highways Department.

Stages of Construction: As explained, the project is proposed to be constructed in two stages viz.

I. the weir stage, and
II. The dam (or ultimate) stage.

First Stage Works:—The following are the main works under the first stage:

(*i*) A diversion weir across the river Sileru at bed level R. L. 1,306, with crest at R. L. 1,340 and 20 ft. high crest gates upto F. R. L. + 1,360.

(*ii*) Earth Dam in the left saddle at about ground level R.L. 1,353, with the bund constructed upto R.L. 1,375.

(*iii*) Earth Dam in the right saddle at about ground level R.L. 1,342 and constructed upto R.L. 1,375.

(*iv*) A regulator with 5 nos. sluices of 12ft. × 8ft. size in the left saddle bund.

(*v*) A forebay with F. R. L. + 1,340 by an earth dam constructed with its top upto R. L. 1,345. Two embankments in the saddles of the forebay, with their top level at R. L. 1,345 and also provision for surplussing spillway in one of the bunds.

(*vi*) In-take works for the penstocks with provision for openings for 7 pipes of 18ft. dia. from the Forebay dam.

(*vii*) Two of 18 ft dia. penstock pipes about 625 ft long each.

(*viii*) Upper Sileru power house at about ground level R.L. 1,120. to accommodate 2 units of 60 m.W. each initially, and suitable for extension for housing 7 units ultimately.

(*ix*) An unlined tail race about 4,600 ft. long to discharge 6,000 cusecs with F.S.L. at R.L. 1,040, suitable for increasing the discharge capacity to 15,600 cusecs ultimately.

(*x*) Necessary generating machinery and switchgear equipment for an installed capacity of 120 m.W.

The estimated cost of the above is Rs. 608 lakhs.

Second Stage Works : In the final stage, the full power potential available at Upper Sileru site will be developed and the following main works are envisaged.

(*i*) Raising the diversion weir to the full height of the dam to provide effective storage of about 100,000 mcft with F.R.L. at about R. L. 1,481.

(*ii*) Raising the earth dams on the right and left saddles of the first stage to their full height upto about R. L. 1,489.

(*iii*) Forming embankments at the saddles at Bandamamidi and Kondakamberu on the right side of the reservoir.

(*iv*) Constructing the Guntavada dam power house at the earth dam at the left flank saddle to accommodate 2 units of 30 m.W. each.

(*v*) Adding more penstock lines of 18ft. diameter each.

(*vi*) Extending the Upper Sileru power house to to accommodate the additional units.

(*vii*) Increasing the width of the tail race to permit the final increased discharge from all the units.

(*viii*) Necessary generating machinery and switch gear equipment for 3 more units of 60 m.W. each.

The estimated total cost of the works for the final stage is Rs. 2,160 lakhs.

Salient Particulars of the Project

The following are the salient particulars of the civil works of the first stage of the project.

(1) *Diversion Weir* :

Crest Level	R.L. 1,340
Average Bed Level	R.L. 1,306
Deepest foundation level	R.L. 1,275
F.R.L.	R.L. 1,360
Crest Gates 20 Nos.	40′ × 20′
Maximum flood discharge (designed)	2,50,000 cusecs.
Length of the spillway including piers	990 ft.
Top of non-overflow section	R.L. 1,368
Total length including non-overflow section	2,150 ft.
Construction sluices 6 Nos.	4′ × 6′ high
Maximum width in foundations including rear apron	148 ft.
Storage between R.L. 1,360 and R.L. 1,350	2,180 m.cft.

(2) *Earth Dam at Left Flank Saddle* :

Lowest ground level at saddle	R.L. 1,352
Top of Bund	R.L.1,375
Length of Bund	3,200 ft.
Slope of front face	1 in 3
Slope of rear face	1 in 2
Top width	30 ft.
Regulator sluices	5 Nos. × 12′ wide × 8′ high
Sill level of supply sluices	R.L. 1,334.5
Bed level of approach channel	R.L. 1,327.5
Scour vent	1 No. × 5′ × 5′
Sill level of scour vent	R.L. 1,334.5

(3) *Earth Dam at Right Flank Saddle* :

Lowest ground level at saddle	R.L. 1,342
Top of Bund	R.L. 1,375
Length of Bund	1,260 ft.
Slope of front face	1 in 3
Slope of rear face	1 in 2
Top width	30 ft.

(4) *Forebay* :

Lowest ground level	R.L. 1,220
F.R.L.	R.L. 1,340
Top of earth dam	R.L. 1,345
Top width	30 ft.
Length of earth dam	2,130 ft.
Length of masonry dam at the penstock intake	480 ft.
Deep foundation level of masonry dam	R.L. 1,220
Minimum draw down level	R.L. 1,330
Effective storage between R.L. 1,330 and R.L. 1,340	64 m.cft.

Penstock openings ..	7 Nos. 18′ diameter
Length of saddle embankment No. 1	1,680 ft.
Length of saddle embankment No. 2	1,500 ft.
Length of spillway for forbay	840 ft.
M.W.L.	R.L. 1,342

(5) *Penstocks* :

Pipes	2 Nos. 18 ft. diameter
Maximum discharge in each pipe	2,640, cusecs
Maximum velocity	10.6 ft./sec.
Length of each penstock ..	625 ft.
Centre of penstocks at intake ..	R.L 1,307

(6) *Power House* :

To accommodate 2 units of 60 M.W. each and a service bay	
Floor level	R.L. 1,059
Centre line of distributor ..	R.L. 1,036
Maximum tail water elevation	R.L. 1,042
Maximum head	315 ft.
Minimum head	290 ft.
Average nett head ..	310 ft.
Overhead travelling Crane ..	1 No. of 300 tons capacity (comprising 2—150 tons cranes with coupling arrangement).

(7) *Tail Race* :

Bed width	60 ft.
Bed level at power house end ..	R.L. 1,020
F.S.L.	R.L. 1,040
Discharge for normal supply depth of 20 ft	6,000 cusecs
Discharge for 22 ft. depth ..	8,200 cusecs
Velocity	4.9 ft./sec.
Bed slope	1 in 4,250
Length	4,600 ft.

Electrical Works

Power Station and Transformer Yard :

Turbines : In view of the large power potential of about 240 m.W. of Upper Sileru and the further power potential of about 400 m.W. at Lower Sileru and the aggregate capacity of the Andhra Grid at the time of materialisation of the Upper Sileru Project, installation of smaller number of bigger units will be economical and be in line with the modern practice. Two 95,000 H.P turbines coupled to 60 m.W. generator are proposed for the first stage.

The turbines will be suitable for an average head of about 310 ft. The turbine will be of Francis vertical reaction type.

Generators :

Two generators each of 60 m.W. capacity are provided for in the estimates for the first stage. Generating voltage is 11 k.V., 3 phase at 50 cycles. Necessary fire protection measures for the generators are provided for.

Two unit transformers 750 k.V.A. capacity solidly connected to the 11 k.V. terminals of generators to ensure dependable power to the auxiliaries in addition to two 750 K.V.A. station transformers are also provided.

The total cost of the generating plant, control gear auxiliaries (works portion) will be about Rs. 131 lakhs.

Step-up Transformer Yard :

The axis of the transformer yard is proposed parallel to the power house. Adequate space provision will be made in the transformer yard for the subsequent stages of development. Suitable benching of the ground will be done and equipment will be placed at nearly the same level as the power house.

Each generating unit will be connected to its own 11/132 k.V. step-up transformer bank on the unit system. Each transformer bank will consist of 3 nos. 25,000 k.V.A. single phase units. Each bank of transformers will be connected to the 132 k.V. bus through a 132 k.V. circuit breaker. The individual feeders are controlled by separate 132 k.V. circuit breakers. Remote pneumatic controlled A.B. Switches in the yard are also provided for.

Three nos. 132 k.V. double deck bays are initially provided from which the Sileru-Rajahmundry 132 k.V. lines and Sileru—Machkund 132 k.V. line take off. Space provision is also made for second 132 k.V. circuit from Sileru to Rajahmundry and from Sileru to Machkund. Arrangements for paralleling Sileru and Machkund stations are also provided for at both Sileru as well as Machkund.

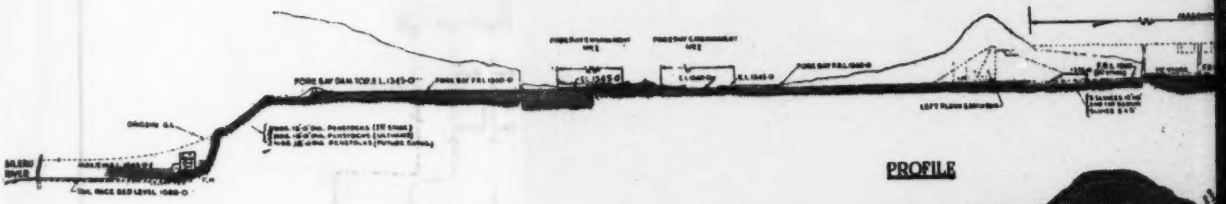
The transformer structures will be of either R.C.C. or lattice steel construction will standard 132 k.V. clearances. An earth screen will be formed over the station which will be bonded to the ground wire of the transmission lines and the station earth bus. Mulsifyre type protection is provided for the transformer yard.

11 k.V. feeders at Sileru will be necessary for feeding local loads. A 11 k.V. auxiliary bus tapped directly from the generator transformer cables for feeding such loads is not considered desirable from operation point of view and safety to the machines. Two nos. 4000 k.V.A. 132/33-11 k.V. step-down transformers are therefore proposed and they are controlled by a 132 k.V. group control circuit breaker. Provision for 3 nos. feeders is made of which one will be 11/33 k.V. feeder to Chintapalli.

The total estimated cost of the transformer yard amounts to about Rs. 45.8 lakhs (works portion).

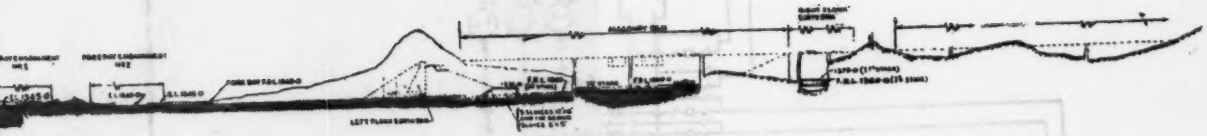
Permanent Local Service Lines :

A sum of Rs. 4.0 lakhs is provided for local power and telephone service lines for supplying power during the construction period. A 33 k.V. line from Koruprolu sub-station will be laid upto Upper Sileru project site with a temporary 33/11 k.V. sub-station at Sileru for making power available for construction requirements.

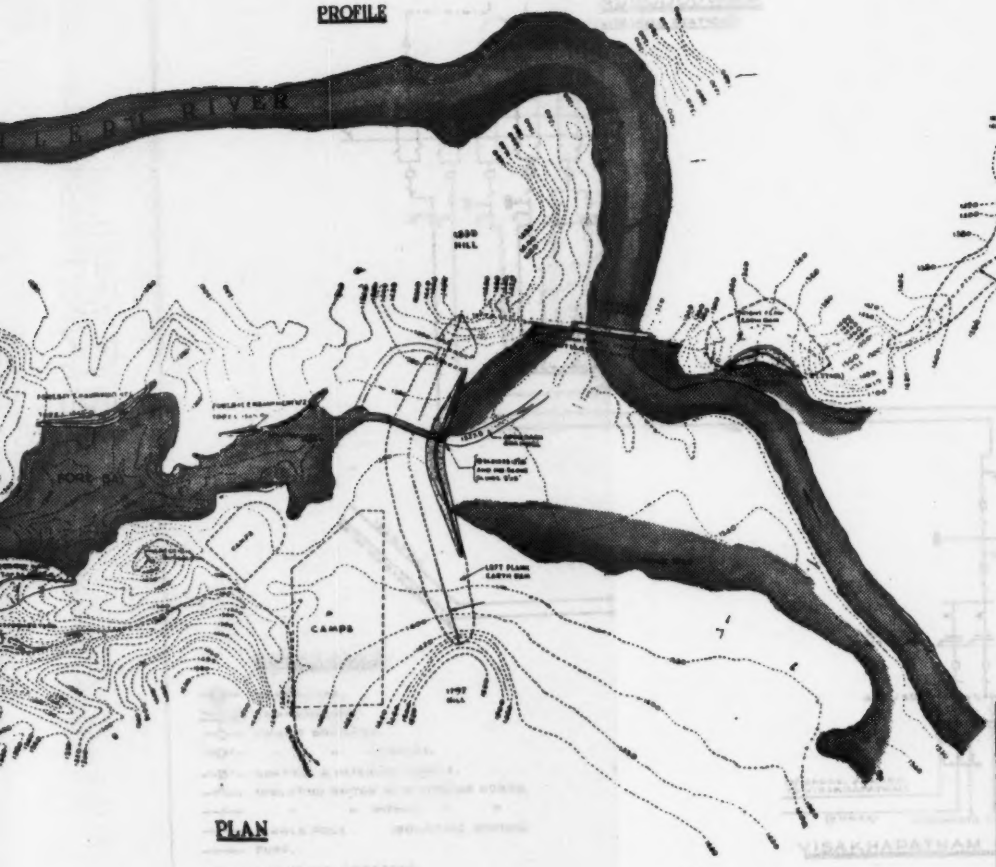


PROFILE

PLAN



PROFILE

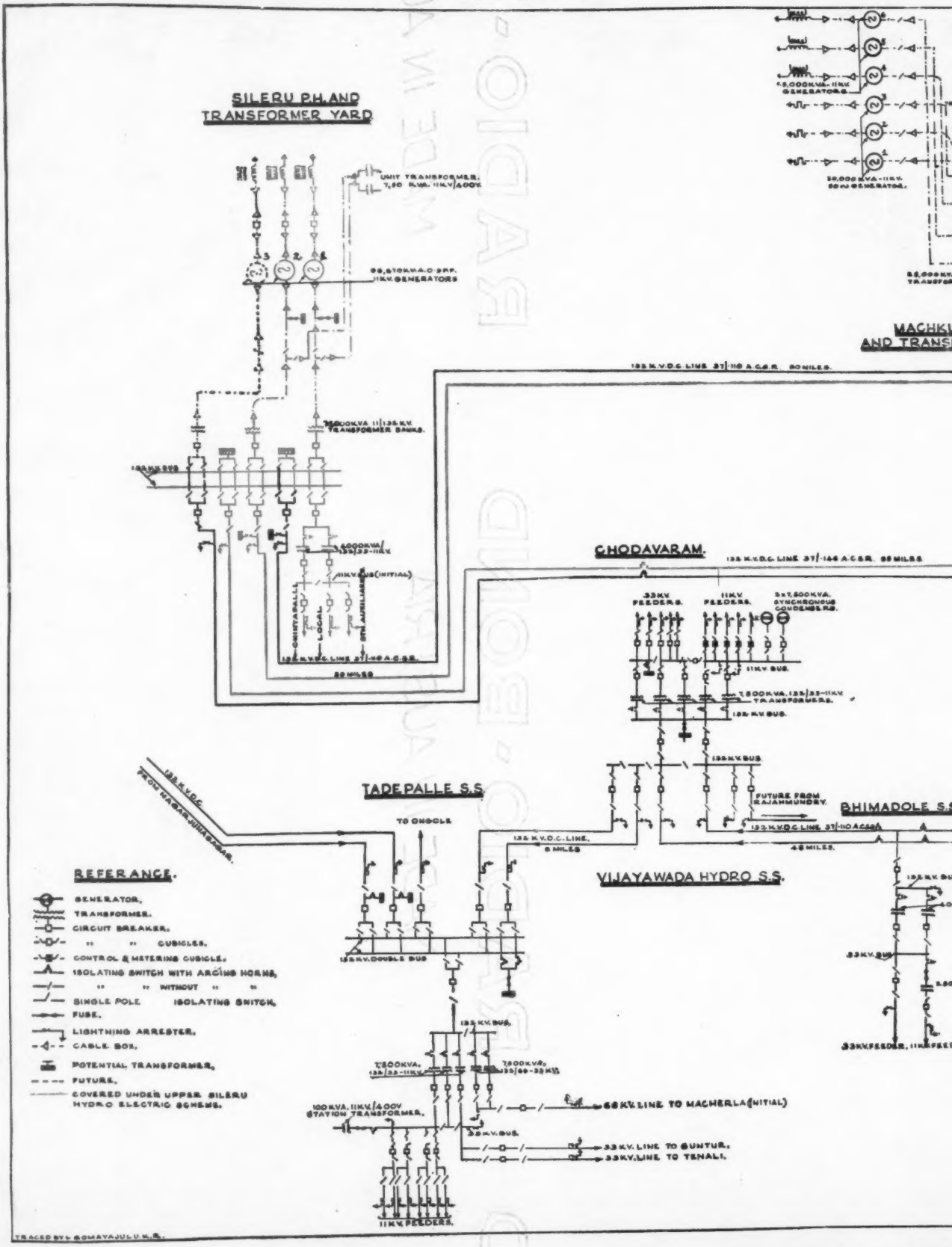


PLAN

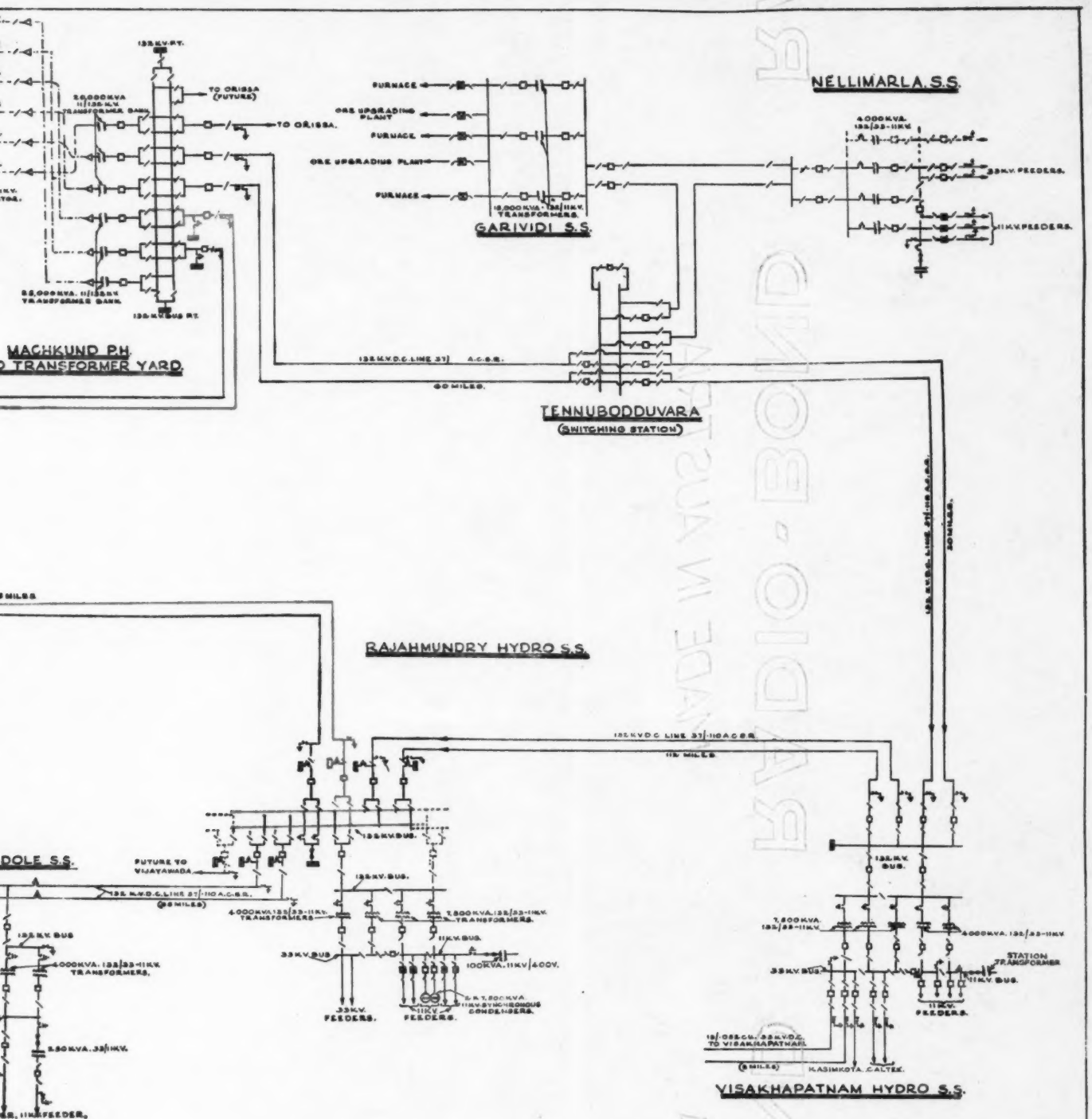
FIRST STAGE WORKS SHOWN IN FIRM LINES & COLOURED
EXTENSIONS SHOWN IN DOTTED LINES

SCALES { PLAN
PROFILE

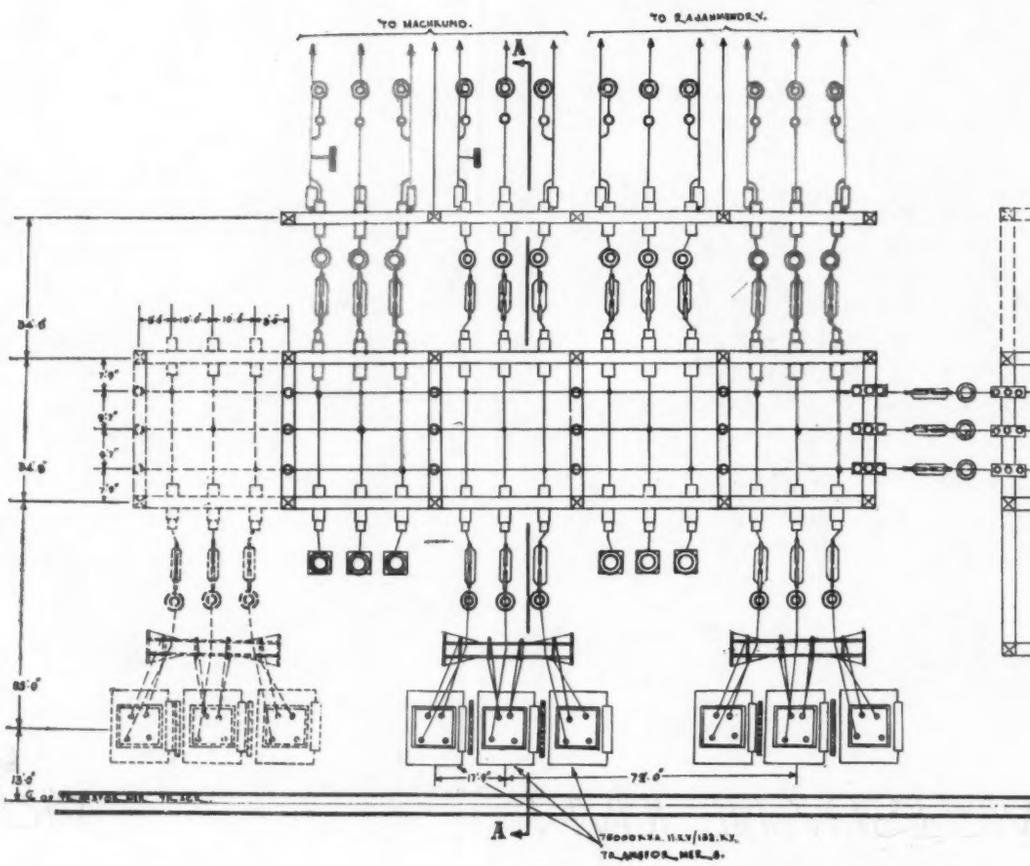
GOVERNMENT OF ANDHRA PRADESH. ELECTRICITY DEPARTMENT	
UPPER SILERU H.E. SCHEME.	
LAY-OUT OF SCHEME	
DRAWN TRACED CHECKED	SUBMITTED RECOMMENDED APPROVED B.R.S
	DRG. No 4/37



TRACED BY: B. SOMAYAJULU, H.S.

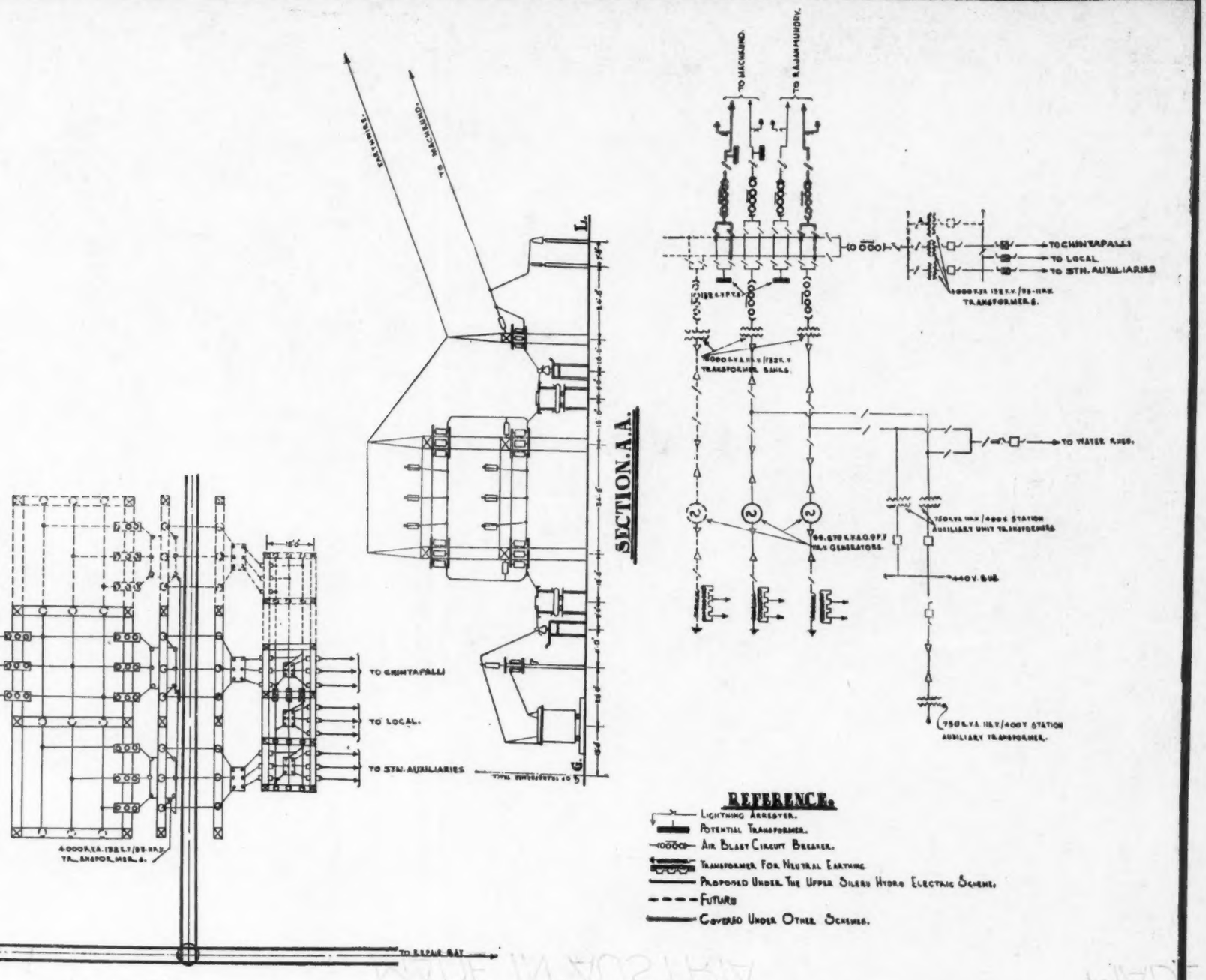


H.E. SCHEME ELECTRICAL LAY-OUT



PLAN.

Drawing
TRACED / PHOTO-SMALL



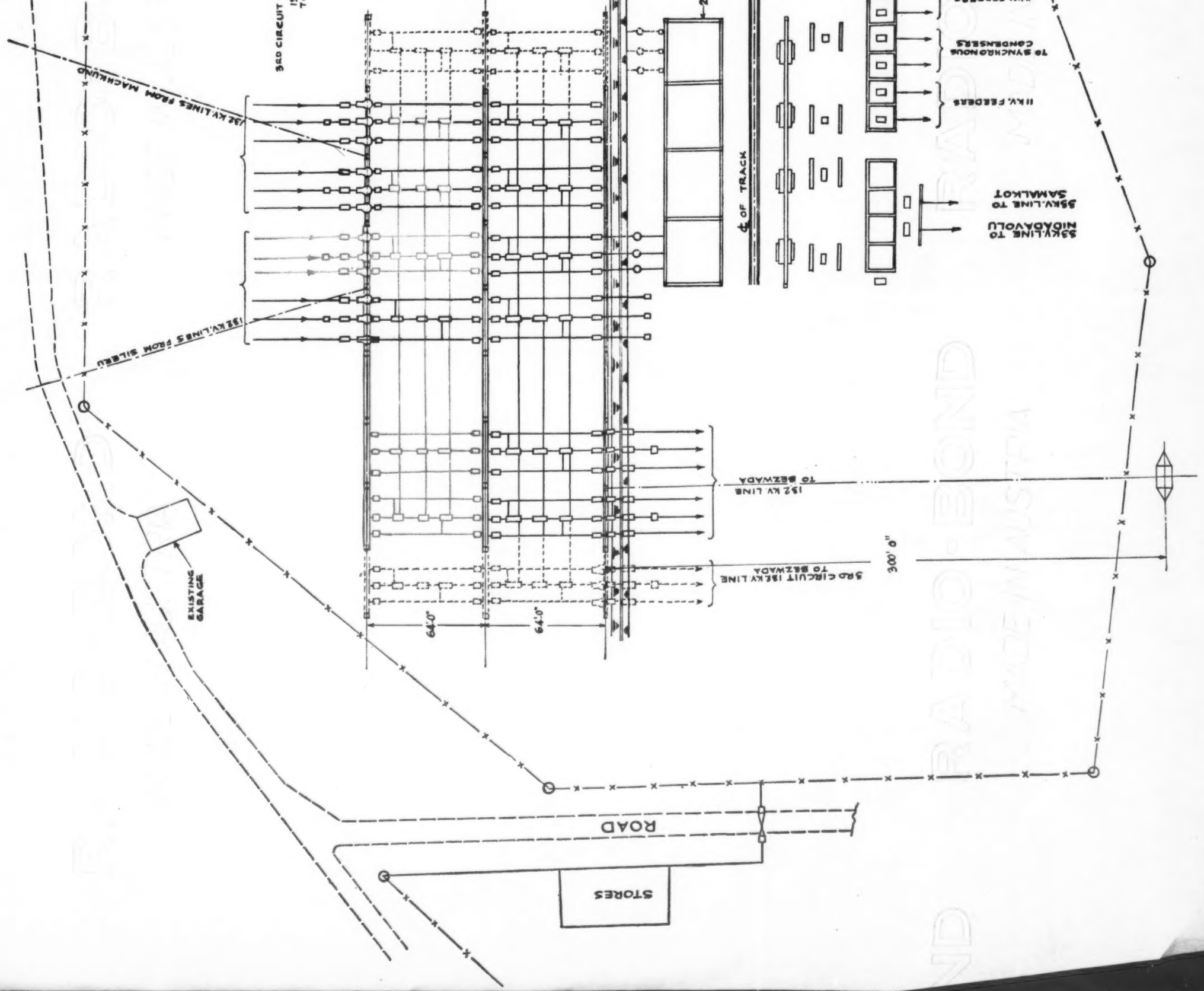
REFERENCE.

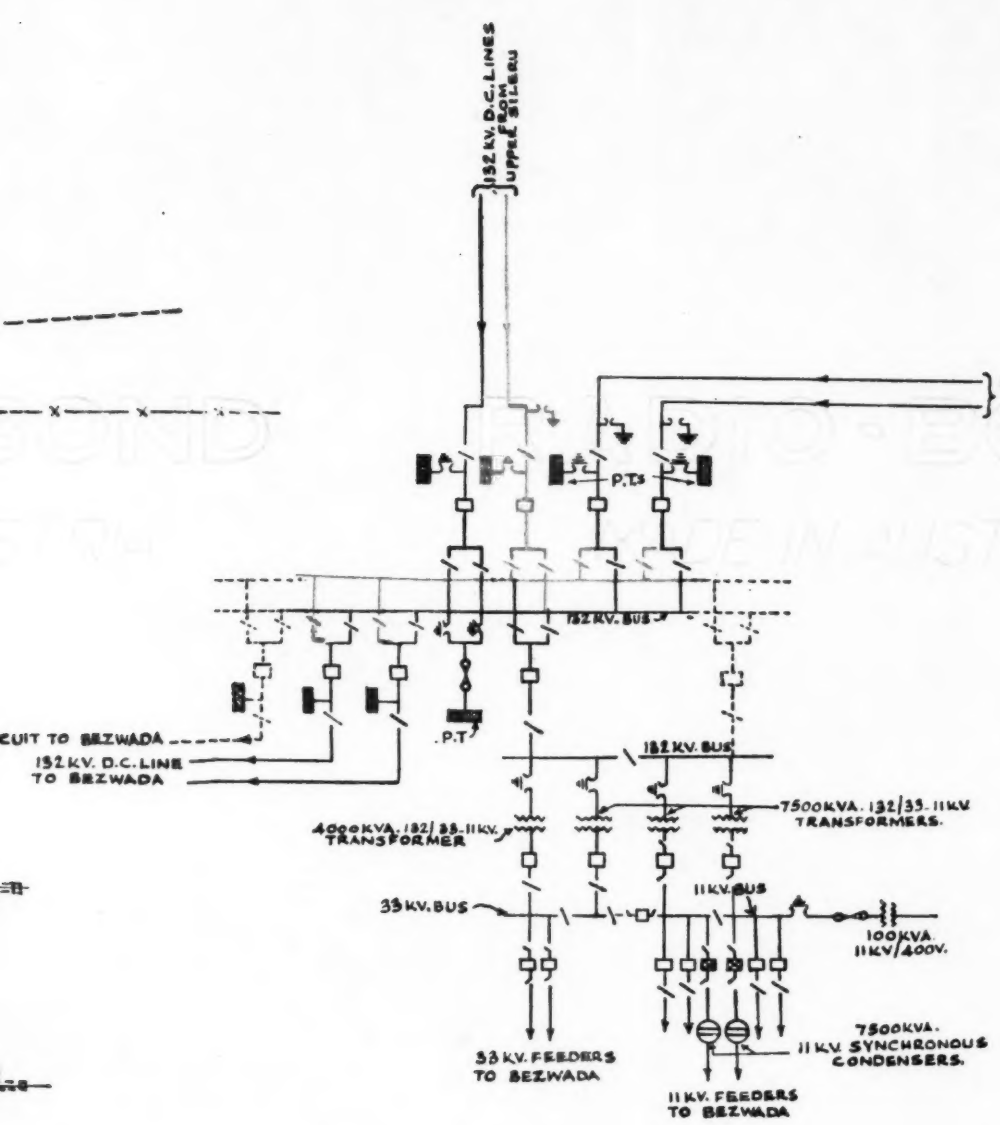
- Lightning Arrester.
- Potential Transformer.
- Air Blast Circuit Breaker.
- Transformer For Neutral Earthing.
- Proposed Under The Upper Sileru Hydro Electric Scheme.
- Future.
- Covered Under Other Schemes.

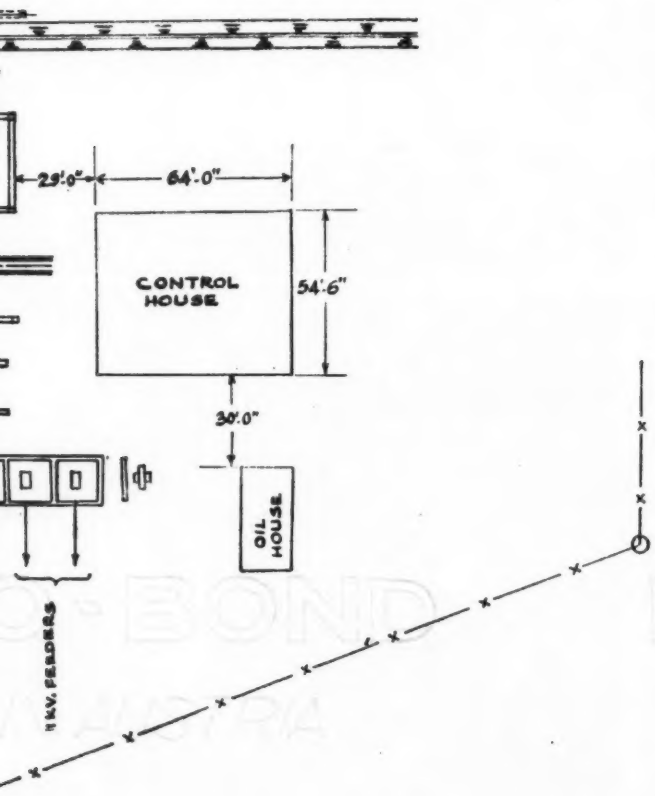
GOVERNMENT OF ANDHRA PRADESH
ELECTRICITY DEPARTMENT.

UPPER SILERU H.E. SCHEME
TRANSFORMER YARD.

DRAWN:-	SUBMITTED:- BPS	
TRACED:-	RECOMENDED:-	
CHECKED:-	APPROVED:-	
	HYDERABAD DEC. 1957.	U.SL.No. 30/57


132 KV LINES FROM MACHKUND
132 KV LINES FROM SILERU
3RD CIRCUIT 132 KV LINE TO BEZWADA
132 KV LINE TO BEZWADA
3RD CIRCUIT 132 KV LINE TO BEZWADA
EXISTING GARAGE
64'-0"
64'-0"
300' 0"
ROAD
STORES
℄ OF TRACK
11 KV. FEEDERS
TO SYNCHRONOUS CONDENSERS
33KV.LINE TO NIDADAVOLU
33KV.LINE TO SAMALKOT





REFERENCE

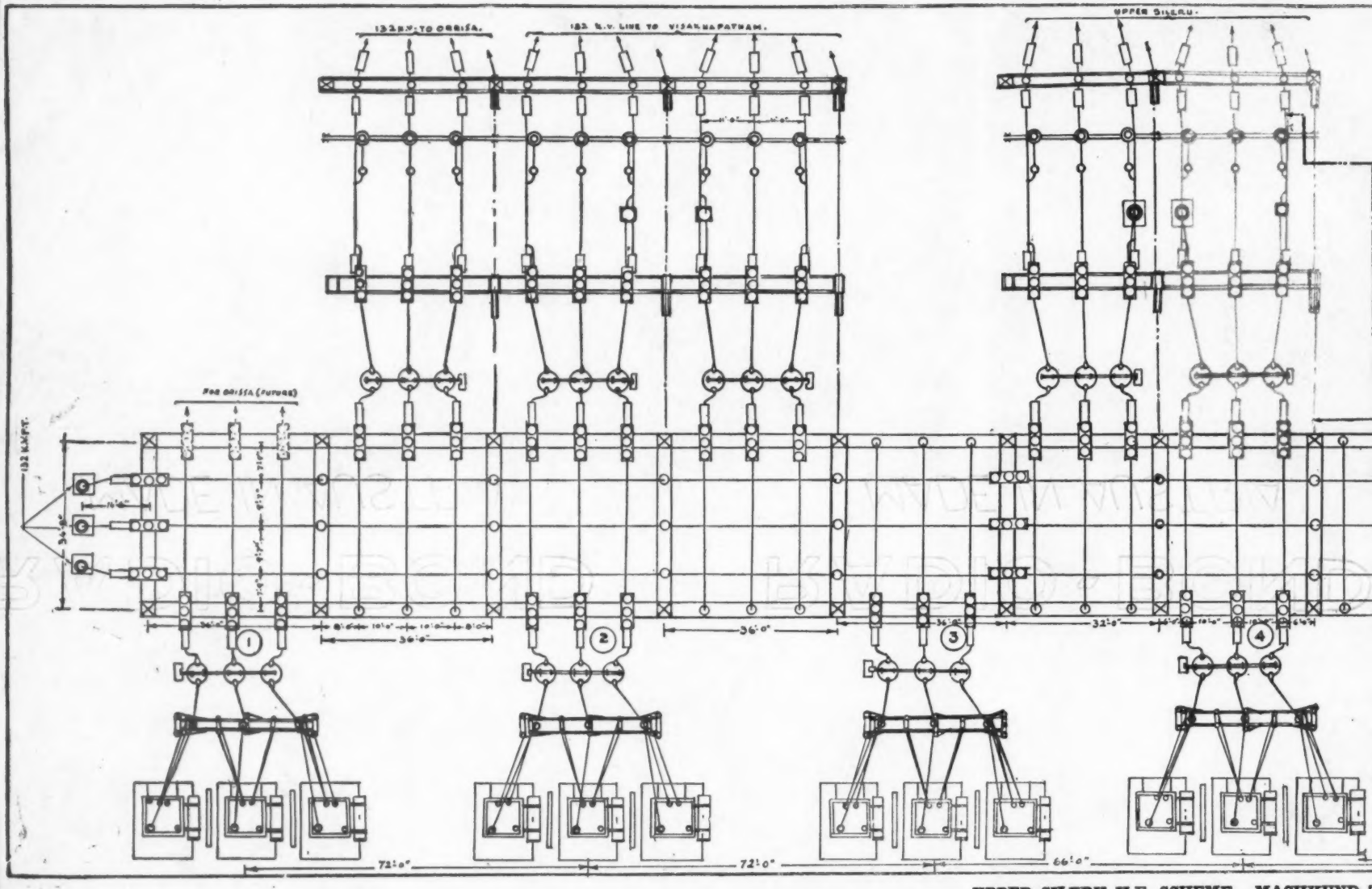
EQUIPMENT COVERED UNDER THE UPPER SILERU HYDRO ELECTRIC SCHEME.
——— EQUIPMENT COVERED UNDER OTHER SCHEMES.
------- FUTURE EXTENSIONS.

GOVERNMENT OF ANDHRA PRADESH
ELECTRICITY DEPARTMENT

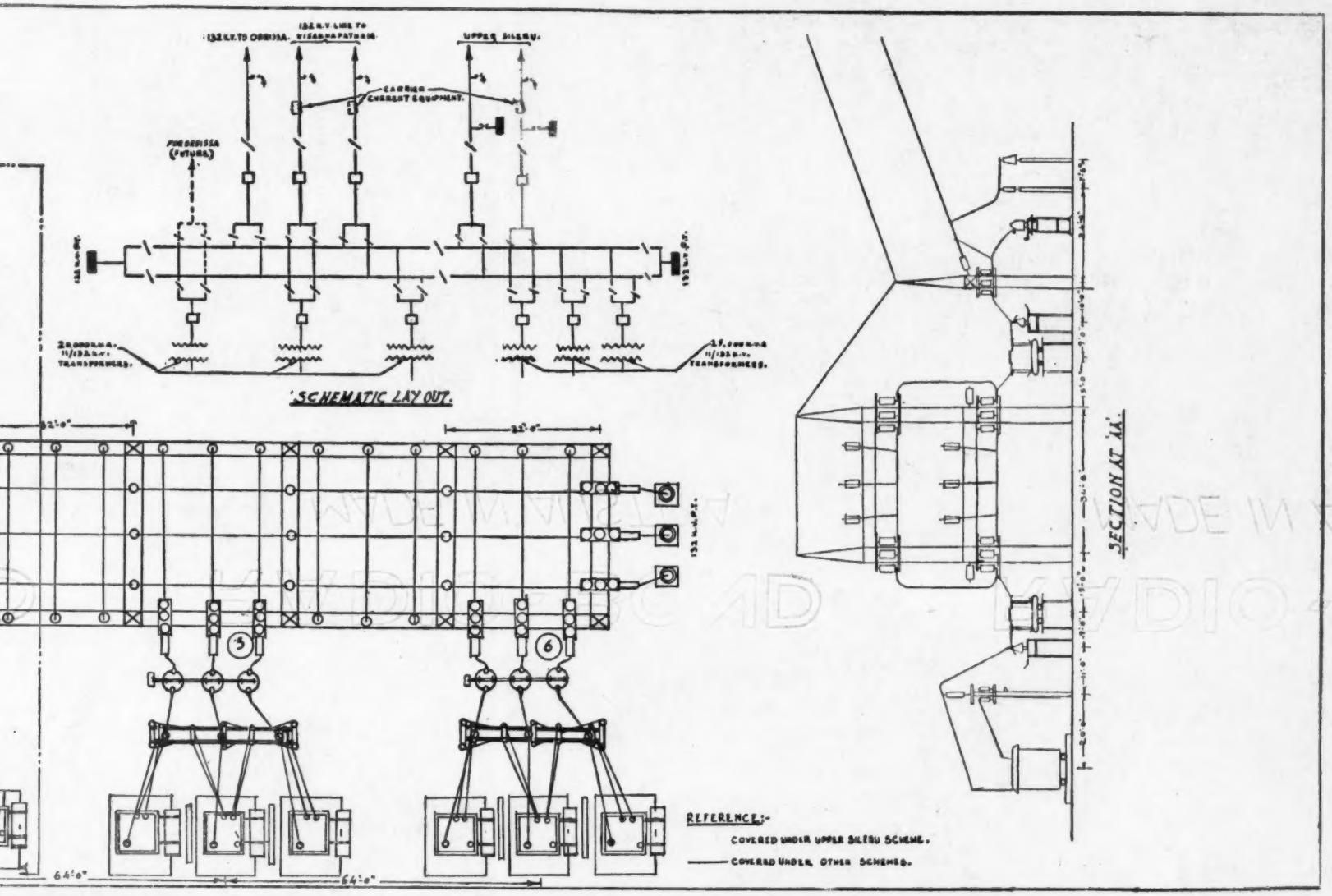
UPPER SILERU H.E. SCHEME.

RAJAHMUNDRY SUB-STATION

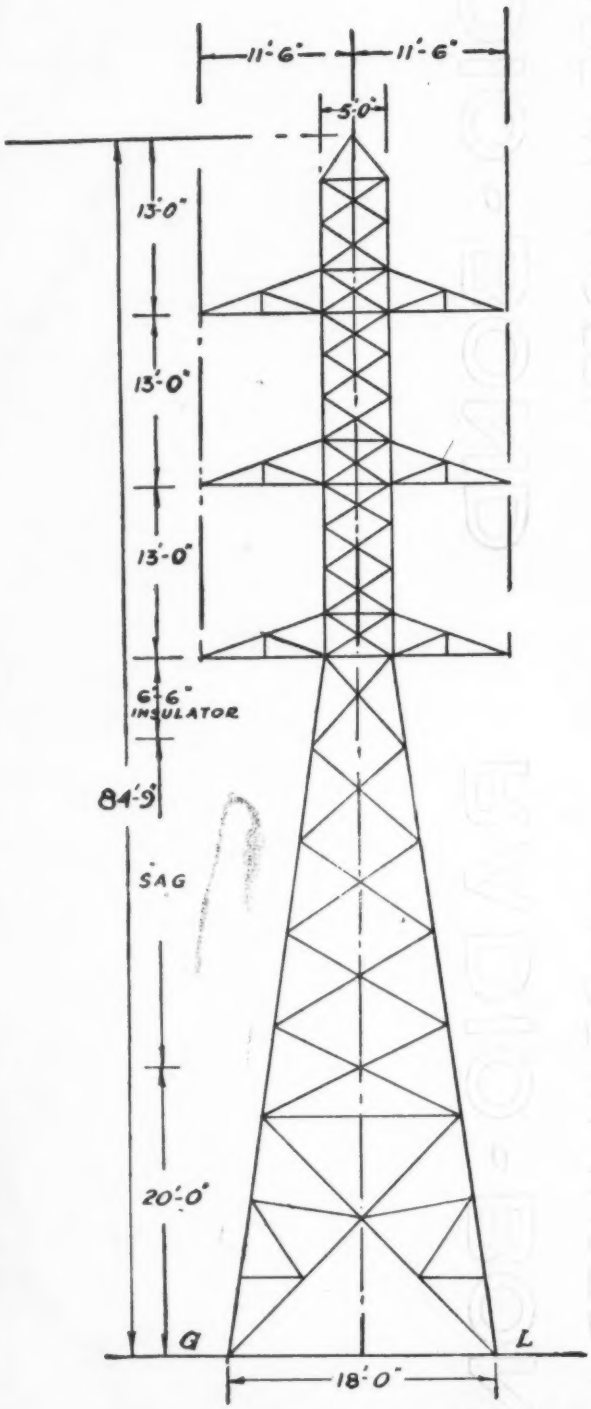
DRAWN TRACED CHECKED SB	SUBMITTED:- BPS RECOMENDED:- APPROVED:-	
	HYDERABAD DEC. 1957	U.SL. No. 31/57



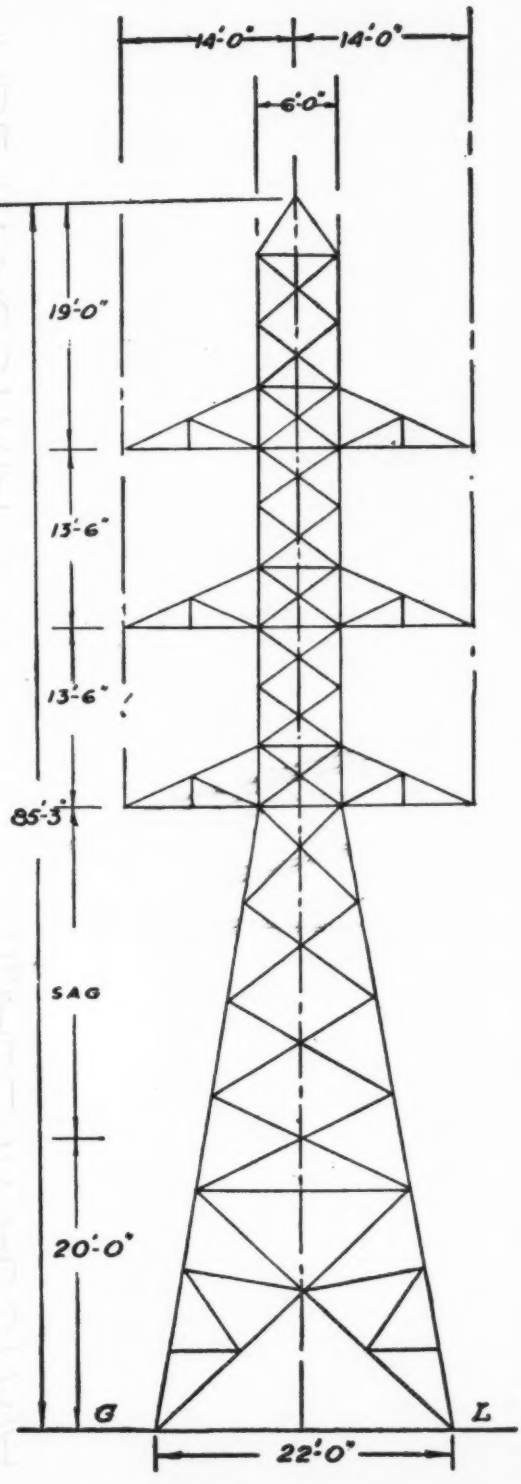
UPPER SILERU H.E. SCHEME. MACHKUND



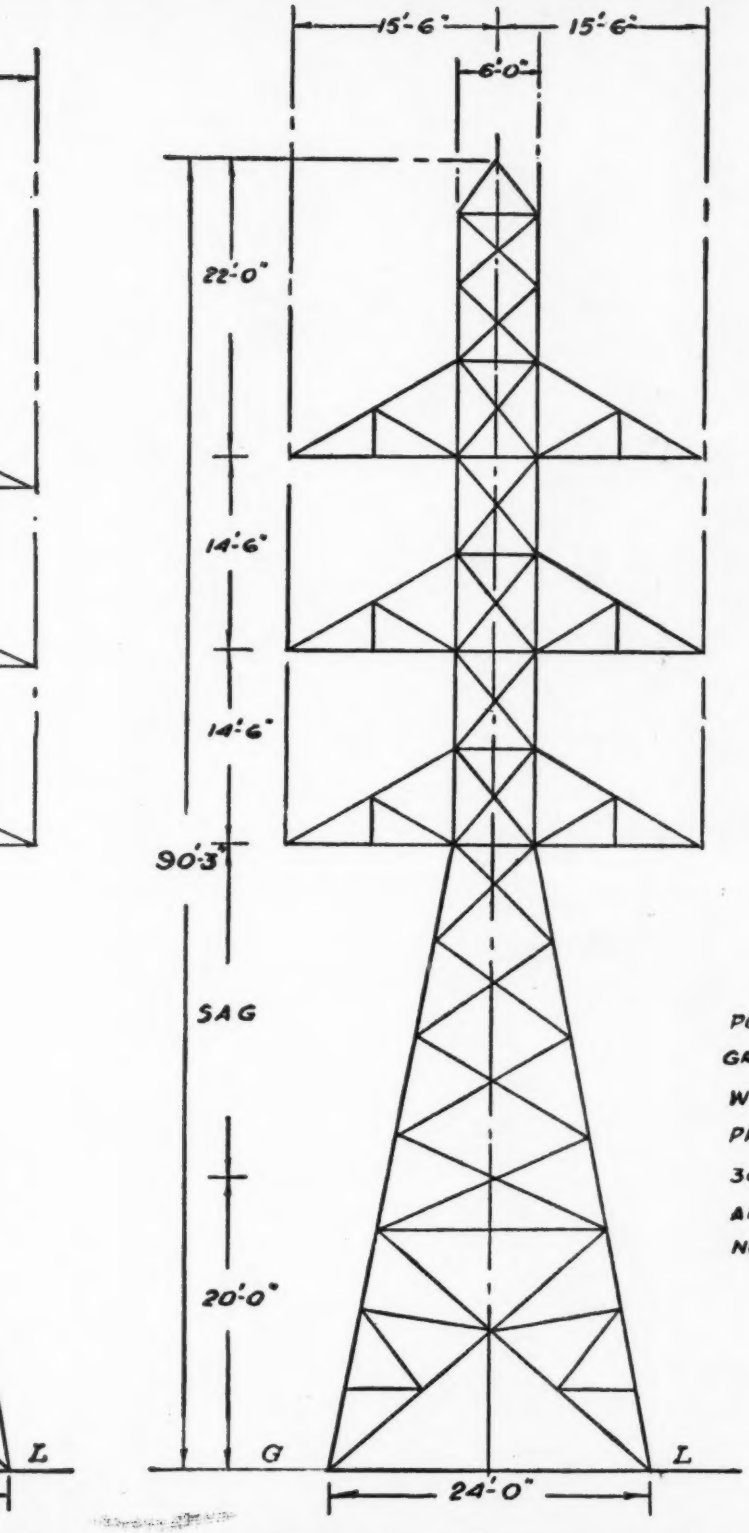
ND TRANSFORMER YARD.



TANGENT TOWER



ANGLE TOWER



DETAILS

POWER CONDUCTOR- 37/0.146"(.30 SQ") A.C.S.R

GROUND WIRE:- 19/.093" G.S. WIRE

WIND PRESSURE - 20lbs/□' ON 2/3 PROJECTED AREA OF CONDUCTOR

30lbs/□' ON 1½ TIMES THE EXPOSED AREA OF ONE FACE OF THE TOWER

NORMAL SPAN:- 1050'

ER

DEAD END TOWER

SUPPORTS FOR 132 K.V. DOUBLE CIRCUIT LINE

Total Cost :

The total estimated cost for the Civil Works and Power Station amounts to Rs. 608/- lakhs.

Transmission Lines and Sub-Stations :

The following transmission lines and sub-stations are provided for :

(*a*) 132 K.V. transmission lines—135 miles covering.
  (*i*) Upper Sileru—Machkund (50 miles).
  (*ii*) Upper Sileru—Rajahmundry (85 miles).

(*b*) extensions to the following existing 132 k.V. sub-stations.
  (*i*) Machkund transformer station.
  (*ii*) Rajahmundry sub-station.

(*c*) 35 k.V. sub-transmission lines—300 miles are provided as indicated below :

(*i*) Tuni—Samalkot	..	40 miles
(*ii*) Chintapalli—Chodavaram—Rajahmundary	..	60 miles
(*iii*) Ongole-Podili-Cumbum	..	65 miles
(*iv*) Narasaraopet—Donakonda	..	40 miles
(*v*) Upper Sileru—Koruprolu	..	90 miles
Total	..	295 miles
say	..	300 miles

(*d*) 35 k.V. sub-station : New sub-stations at Chintapalli, Chodavaram, Donakonda, Podili, Cumbum are provided at Rs. 10.0 lakhs. An additional amount of Rs. 7.5 lakhs for increase in transformer capacities at various existing sub-stations is provided for in the 10 year period. A temporary sub-station at Upper Sileru is provided at a cost of Rs. 2.5 lakhs for construction power. The total provision under this sub-head is Rs. 20.0 lakhs.

A provision of Rs. 2.5 lakhs is made in the estimate for the carrier current telephone equipment, in addition to land telephone.

The total estimated cost of the civil works and power station, transmission lines and sub-stations works out to Rs. 593 lakhs initially rising to about Rs. 802 lakhs by the end of third year of operation.

As per the phased programme of construction, Upper Sileru Hydro Electric Scheme, first stage, is expected to go into operation by the third year of construction i.e. 1960-61 and fully completed by the end of the 3rd year of operation i.e. 1963-64.

Load Forecast

The table below gives the progressive Andhra demand met by Machkund scheme and the corresponding share of the total demand coming on Upper Sileru.

Year	*Total demand as per Machkund scheme report stage* II. *(Andhra)*	*Andhra demand met by full development of Machkund.*	*Demand met at power house*	*Deficit of power*
1956-57	33,000	33,000	..	..
1957-58	75,300	61,850	..	..
1958-59	89,600	89,600	..	..
1959-60	99,300	99,300	..	..
1960-61 Operation period of Sileru.	105,030	99,700	..	..
1961-62	113,300	77,000	36,300	..
1962-63	132,300	77,000	45,300	..
1963-64	132,300	77,000	55,300	..

The figures show that the load development in the Machkund-Nellore zone cannot be met by the Machkund scheme even with the full development beyond 1959-60 i.e. Sileru scheme has, therefore, to be taken up for execution in the Second Plan and completed at least by 1960-61 to avoid power shortage in this zone from 1961-62.

As per the above forecast, the load on Sileru Powerhouse will be 36.3 m.W. in 1961-62 rising to 55.3 m.W. in the year 1963-64. In other words the effective capacity of the station will be fully utilized in the third year of operation itself.

Financial Forecast

The financial results of the project are summarised below :

Capital outlay at the end of ten years	Rs. 802.60 lakhs
Arrears of interest at the end of ten years	..
Sum at charge	802.60 lakhs
Revenue rate	180 per k.W. per year
Net revenue at the end of ten years	90.50 lakhs
Net percentage return	11.2%

The scheme is therefore highly remunerative.

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Telengana Hydro-Thermal Scheme

The Telengana region in Andhra Pradesh for which this power scheme is prepared has an area of about 43,000 square miles and a population of about 11 millions. About 80% of the population live in villages and agriculture is the main source of employment. The Telengana area comprises the nine districts of Hyderabad, Mahaboobnagar, Warangal, Khammamet, Kareemnagar, Nizamabad, Medak, Nalgonda and Adilabad.

The region is rich in minerals, the most important of them being coal. The collieries in the area have a unique advantage of proximity with industries and railways in South India. Coal reserves of the State are placed at over 1000 million tons. Production is at present of the order of 15 lakhs of tons per year.

Power Position at the beginning of Second Plan period

At the commencement of the second five year plan period Hussainsagar Thermal Station at Hyderabad interconnected with Nizamsagar Hydro Electric Power Station mainly catered to the needs of the twin cities of Hyderabad and Secunderabad.

There were a few small and scattered Diesel Stations catering to local areas. In addition to the above, small bulk power was purchased in a few cases from industrial concerns and distributed in the neighbouring areas. A few major industries continued to develop their own power requirements. This was due to non-availability of adequate power from the State-owned generating stations and a transmission line grid for the whole area. There were only 15 electrified locatlities of which 10 are under State owned distribution schemes, two belonged to Licensees and the balance three localities received power in bulk purchased from the neighbouring industries and distributed by the State.

There are about 10,000 villages and towns in the Telengana area and as stated above only an insignificant number of villages have been so far electrified. The power development in the Telengana area is therefore more or less restricted to the Hyderabad and Secunderabad cities and the development in the moffusil is very trivial. The aggregate demand met all over the Telengana from the above sources as on 1-4-56 is only of the order of 18,000 kWs.

The per capita consumption is only 5 which is one of the lowest figures for any State in India.

The above factors indicate the backwardness of the area in the matter of power development and the necessity for a broad based development programme to be launched in the near future.

Second Five Year Plan Power Projects-Telengana Area

The second Five Year Plan provisions for the Electricity Schemes in the Telengana area as break up figures for the former Hyderabad State are indicated below. The total cost of each scheme as already prepared as also the approximate expenditure to end of 1955-56 i.e. to the end of the first plan period are also indicated in the statement.

Name of the Scheme.	*Approximate Total cost.*	*Expenditure to end of 1st Plan period i.e. end of 55-56*	*IInd Plan provision*	*Spill over into 3rd Plan*
	..... In Lakhs of Rupees			
Spillover Schemes				
Ramagundam Thermal Schemes	500.00	300.00	137.05	62.95
Rural Electrification Scheme	..	..	27.20	..
Nigamsagar Hydro Electric Project	251.10	234.00	17.10	..
New Schemes				
Devanoor Hydro Electric Project	600.00	..	220.00	380.00

Contd.

Name of Scheme	*Approximate Total cost.*	*Expenditure to end of 1st Plan period i.e. end of 55-56.*	*2nd Plan. provision.*	*Spill over into 3rd Plan.*
Reorganisation of City Electricity Supply net work	100.00	..	85.50	14.50
Ramagundam Thermal station Extension.	115.00	..	38.20	42.60
Northern Feeder (66 kV) Ramagundam upto Sirpur			19.20	
Rural Electrification Scheme	..	..	43.70	..
Investigation of Projects.	..	..	3.80	..
			591.75	

Under the Rural Electrification Scheme, a number of pilot diesel stations as nursery schemes are envisaged and included in the Second Five Year Plan provision in items 2 and 8. A list of these nursery schemes is furnished below.

1. Medak Rural Electrification Scheme.
2. Tandur Rural Electrification Scheme.
3. Jangaon Rural Electrification Scheme.
4. Nirmal Rural Electrification Scheme.
5. Bunsvada Rural Electrification Scheme.
6. Bhongir Rural Electrification Scheme.
7. Adilabad Rural Electrification Scheme.
8. Nalgonda Rural Electrification Scheme.
9. Yellareddy Rural Electrification Scheme.

The provision of Rs 27.2 lakhs against item no. 2 and Rs. 43.7 lakhs under item 8 in the table above are the breakup figures for the Telengana area out of total figure of Rs. 47.5 lakhs and 77.5 lakhs for the entire former Hyderabad State.

Ramagundam Thermal Scheme

A brief description of this scheme which is the most important of the Second Plan schemes for Telengana area has been given elsewhere in this issue.

The design of the station seems to have been based upon the idea of distributing large amount of power at 11 kV locally for some industries. The amount of effective step-up transformers capacity for transmission at 66 kV was therefore limited to less than half of the station capacity. The position is now different. There is no prospect of any bulk loads near power house to supply directly at 11 kV. Hence almost the full amount of power has to be stepped upto 66 kV for transmission to north, south and south-east. The extra transformer capacity necessary is being now provided.

The effective capa ity of the station is also limited by boiler capacity. Out of 6 boilers, one boiler will be out of commission throughout the year in rotation for statutory boiler inspection. One out of the remaining 5 boilers may also have to be reckoned as standby. An effective steam capacity of 200,000/250,000 lbs/hr only will thus be available throughout the year. This corresponds to about 16,000/20,000 kW effective firm output of the Station.

There is only one cooling tower capable of handling water required for a load of about 25,000 kWs. To make the station effective for supplying 25 mW. it is necessary:

(1) to increase the step-up transformers capacity by installing two more 15,000 kVA 11/66 kV transformers;

(2) install one more boiler of 150 thousand pounds per hour capacity;

(3) another cooling tower capable of handling circulating water necessary for 25,000 kWs. of power.

Further large bulk loads are coming up north of Ramagundam Power Station. These are Mancherial Cement Factory requiring about 3,400 kWs. initial rising to 6,000 kWs. by 1958 Bellampalli Colleries requiring 4,000 kWs. and Sirpur Paper Mills and Sirsilk Factory requiring bulk power of 4,600/6,000 kW. To cater to these loads, it is necessary to build 66 kV double circuit line from Ramagundam to Sirpur, along with the necessary stepdown sub stations at Mancherial, Bellampalli and Sirpur. In other words not only the 66 kV D. C. line from Ramagundam to Hyderabad (Yerraguda Sub Station) is required to augment power supply at the twin cities of Hyderabad and Secunderabad as originally sanctioned, but additional 66 kV transmission lines necessary for utilization of the power available at Ramagundam Power Station as covered by this overall Telengana Scheme will be essential.

The practice in Andhra area is to have major projects prepared taking into account the initial capital investment in the construction period and further investment in the 10 years operation period and co-relate it with the load and revenue forecast in the 10 years period. For the total sum at charge i. e. the total capital investment at the end of 10 year operation period plus

the accumalted arrears of simple interest calculated at the rate of 4½ per cent on capital expenditure, the total revenue in the 10 year should fetch a minimum net return of 4½% (after meeting working expenses and excluding interest) to be classified as productive. No such procedure appears to have been adopted in the case of any schemes under excution or schemes for which sanction has been sought and are included in the Second Five Year Plan in Telengana so far. It is therefore necessary to prepare comprehensive scheme for the whole of the Telengana area on a 10 year period and on net return basis. Further to have an integrated system of working, it is essential to combine into a consolidated project estimate, all the 3 sanctioned schemes, viz., Ramagundam and Hyderabad Thermal Stations and Nizam Sagar Hydro Station. Merging of the above three station schmes under one project estimate will facilitate coordination between budgetary position and planning and also rationalisation of development of power over the whole area and the close watch of the revenues related to capital expenditure. It is essential that the project includes a provision for construction of the necessary 33/11 kV Sub-transmission lines and sub-stations for utilising the power that becomes available at the three power stations which are interconnected for efficient and economic operation. The present report is prepared to cover the transmission lines and sub station also.

Telengana Hydro Thermal Scheme

The present scheme provides for the following works :—

(1) Balance works relating to Hussain Sagar Thermal Scheme, Nizam Sagar Hydro Electric scheme, Ramagundam Thermal Scheme, City Reorganisation scheme, etc. on which an expenditure of about Rs. 684 lakhs has already been incurred. (2) Spill over schemes from the first Five Year Plan at an estimated cost of Rs. 154.15 lakhs against Ramagundam Thermal Scheme and Nizam Sagar Hydro Electric Scheme. (3) Additional works that are essential for making the Telengana Project entirely comprehensive and for the full utilization of power that will be available from Ramagundam Power Station. The additional works are furnished below :

(*i*) The installation of one more 150,000 pounds per hour boiler at Ramagundam Power Station during the Second Five Year Plan period.

(*ii*) One natural draught cooling tower during the Second Five Year Plan period.

(*iii*) 2 Nos. of 15,000 kVA 11/66 kV Step-up transformers at Ramagundam Power Station.

(*iv*) 66 kV double circuit line from Ramagundam to Sirpur.

(*v*) Works relating to Hyderabad City Distribution scheme including the installation of a 75,000 pounds per hour capacity boiler at Hussain Sagar Power Station. It is proposed to execute the works covered by items (*iii*) (*iv*) and (*v*) during the Second Five Year Plan period.

(*vi*) About 816 miles of 33 kV Single Circuit lines.

(*vii*) About 320 miles of 11 kV line.

(*viii*) Provision is also made for 7 nos. 66 kV substations and 25 nos. 33/11 kV Sub Stations and the Telephone lines.

(*ix*) 4 Central Diesel Stations at Nirmal, Nizambad, Nizamsagar and Mohaboobnagar and 60 pilot diesel stations.

When all the transmission lines included in the scheme are constructed and commissioned they will cover most of the area of 9 districts constituting the the Telengana region.

The necessary distribution for consuming the power generated from the power houses will be covered under separate remunerative rural or village electrification schemes which will be sanctioned from time to time as and when investigations are completed. The Telengana project report does not include such village electrification estimates.

Inter-Connection between the Power Stations and Formation of an Integrated Grid for Andhra Pradesh

The Telengana Hydro Thermal Scheme as now presented contemplates the interconnected and co-ordinated operation of the three major power stations at Hussain Sagar, Nizam Sagar and Ramagundam through the main 66 kV lines. The proposal envisages the four central diesel stations also operating and feeding into net work of Sub-transmission lines whenever necessary and especially when the power output from Nizamsagar goes down during the off irrigation season

The inter-connection between the various power stations will facilitate economic and co-ordnated operation as indicated below :—

(*i*) Hussain Sagar Power Station Plant is considerably old and cost of generation at this power house is high. By interconnecting it with Ramagundam, the Hussain Sagar Power Station can be made to work only to the extent required while Ramagundam Power Station works as a base load station.

(*ii*) The inter-connection of Nizam Sagar Power House will likewise serve especially during irrigation period to meet appreciable amount of Hyderabad load with consequent reduction in the load of Hussain Sagar Power House and savings in the operating and fuel costs at Hussain Sagar Power House.

(*iii*) The Central Diesel Stations will facilitate meeting the loads around them through sub-transmission lines when power output from Nizan Sagar goes down in the off irrigation period and thus firm up the power output from Nizam Sagar Power Station to the extent of 4,000 kW.

(*iv*) The 66 kV. inter connection between the Telengana Hydro Thermal area with Tungabhadra and Machkund Zones serve not only to augment power position in the Telengana zone by cheap hydro power but results in the preliminary stage development of an integrated grid for Andhara Pradesh State. These 66 kV. lines will also facilitate extension of supply at intermediate places enroute.

TABLE 1

Telangana Hydro Thermal Scheme.

Load Forecast

Sl. No. (1)	*Particulars.* (2)	56-57 (3)	57-58 (4)	58-59 (5)	59-60 (6)	60-61 (7)	61-62 (8)	62-63 (9)
	Demand as estimated by Central Water & Power Commission in—							
1.	Hyderabad district	17710	20025	21886	24390	26360	28400	31400
2.	Mahabubnagar district.	341	448	735	868	1323	1423	1640
3.	Warangal & Khammamet Districts.	1854	2618	3149	3890	4393	5400	6400
4.	Karimnagar district.	602	1713	2675	3561	4764	5100	5700
5.	Nizamabad district.	408	567	660	830	1148	1348	1500
6.	Medak District.	91	192	403	581	877	1027	1175
7.	Nalgonda district.	..	271	576	940	1331	1440	1560
8.	Adilabad district.	156	14941	17412	17737	19293	20500	22000
	Total (k.W.)	21162	40775	47496	52777	59490	67638	71735
9.	Total demand anticipated on a conservative basis excluding remote bulk and heavy industrial loads.	18000	27000	34550	43000	46000	50000	55000
10.	Demand met by Hussainsagar power Station.	16000	15000	15000	15000	15000	15000	15000
11.	Demand met by Ramagundam Power Station	2000	10000	16500	18000	21000	23000	24000
12.	Power purchased from Machkund zone at Macherla.	..	..	..	3000	3000	3000	3000
13.	Power purchased from Tungabhadra zone at Kurnool.	..	..	..	3000	3000	3000	3000
14.	Demand met by the combination of Nizamsagar and the central diesel stations at Nizamsagar, Nizamabad bad, Nirmal and Mahabubnagar.	..	2000	3000	4000	4000	4000	4000
15.	Total Demand met by the items 11 to 15. (k.W.)	18000	27000	34550	43000	46000	48000	49000
16.	Deficit or surplus in the area.	..	..	..	..	..	—2000	—6000

Particulars. (2)
Demand as estimated by Ce Water & Power Commissio
Hyderabad district
Mahabubnagar district.
Warangal & Khammamet Dis
Karimnagar district.
Nizamabad district.
Medak District.
Na'gonda district.
Adilabad district.
Total (k.
Total demand anticipated on vative basis excluding rem and heavy industrial loads
Demand met by Hussainsagar power Station.
Demand met by Ramagundam Station
Power purchased from Machk at Macherla.
Power purchased from Tungs zone at Kurnool.
Demand met by the combina Nizamsagar and the centr stations at Nizamsagar, Ni bad, Nirmal and Mahabub
Total Demand met by the 11 to 15. (k.W
Deficit or surplus in the area.

TABLE I

Telangana Hydro Thermal Scheme

Load Forecast

	56-57 (3)	57-58 (4)	58-59 (5)	59-60 (6)	60-61 (7)	61-62 (8)	62-63 (9)	63-64 (10)	64-65 (11)	65-66 (12)	*Remarks.* (13)
ed by Central Commission in—											
	17710	20025	21886	24390	26360	28400	31400	33400	35900	38400	
ict.	341	448	735	868	1323	1423	1640	1800	1980	2184	
namet Districts.	1854	2618	3149	3890	4393	5400	6400	7300	8100	9030	
.	602	1713	2675	3561	4764	5100	5700	6000	6800	7143	
	408	567	660	830	1148	1348	1500	1700	1900	2052	
	91	192	403	581	877	1027	1175	1220	1340	1489	
	..	271	576	940	1331	1440	1560	1690	1800	2030	
	156	14941	17412	17737	19293	20500	22000	23500	25000	26544	
Total (k.W.)	21162	40775	47496	52777	59490	67638	71735	77610	82820	88072	
ipated on a conser- luding remote bulk trial loads.	18000	27000	34550	43000	46000	50000	55000	58000	61000	65000	
ssainsagar	16000	15000	15000	15000	15000	15000	15000	15000	15000	15000	
magundam Power	2000	10000	16500	18000	21000	23000	24000	25000	25000	25000	
om Machkund zone	..	..	..	3000	3000	3000	3000	3000	4000	5000	
rom Tungabhadra .	..	..	..	3000	3000	3000	3000	3000	3000	3000	
he combination of the central diesel msagar, Nizamabad l Mahabubnagar.	..	2000	3000	4000	4000	4000	4000	4000	4000	4000	
et by the items (k.W.)	18000	27000	34550	43000	46000	48000	49000	50000	51000	52000	
n the area.	..	..	..	..	..	—2000	—6000	—8000	—10000	—13000	

Sl. No.	Particulars.	Expenditure upto 31-3-56	56-57	57-58
1.	Ramagundam Thermal Scheme including step-up station	264	78.99	6.17
2.	Transmission Lines and sub-Stations, Rural Electrification & Diesel Stations.	65	51.75	170.4
3.	Hussainsegar Power Station including Hyderabad and Secunderabad.	150		
4.	Nizamsagar Hydro-Electric Scheme	205	17.10	17.7
		684	147.84	194.27

TABLE 2

dro Thermal Scheme Capital Expenditure Programme

Year of Operation

57-58	58-59	59-60	60-61	61-62	62-63
		—Rupees in lakhs.—			
6.17	18.5	15.0	15.0	40.0	
170.4	142.0	48.0	47.78	182.25	78.8
17.7	..	..	..	..	..
194.27	160.5	63.0	62.78	222.25	78.8

TABLE 2

...engana Hydro Thermal Scheme Capital Expenditure Programme

					Year of Operation						
56-57	**57-58**	**58-59**	**50-60**	**60-61**	**61-62**	**62-63**	**63-64**	**64-65**	**65-66**	***Total.***
			—Rupees in lakhs.—							
78.99	**6.17**	**18.5**	**15.0**	**15.0**	**40.0**	..	..	..	..	**437.66**
51.75	**170.4**	**142.0**	**48.0**	**47.78**	**182.25**	**78.87**	**56.60**	**34.38**	**18.53**	**895.75**
..	..	..	..	..	..	..	..	..	..	**150.00**
17.10	**17.7**	..	..	..	..	..	..	..	..	**239.8**
147.84	**194.27**	**160.5**	**63.0**	**62.78**	**222.25**	**78.87**	**56.60**	**34.38**	**18.53**	**1723.21**

Sub-Stations and Transmission Lines

The designs of sub stations and transmission lines are as per those already adopted in the Andhra Area and found satisfactory. The voltage regulation at the several sub-stations is found to be satisfactory.

Estimates

The itemised estimates amounts under this Telengana Power Project for which revised administrative approval of the Government is required are :

	Rs. in lakhs
(*i*) Ramagundam Thermal Scheme	437.66
(*ii*) Transmission Lines & Sub Stations City Distribution Reorganisation & Diesel Stations	895.7
(*iii*) Hussain Sagar Thermal Scheme and Existing Secunderabad Hyderabad Distribution. (Depreciated value)	150.00
(*iv*) Nizamsagar Hydro Electric Scheme	239.8
	1723·16

In the case of item No. (*iii*) above depreciated value of the assets has been taken in as much as they have been in service for considerable number of years. The total book value of these assets as on 31-3-1956 is approximately Rs. 268.00 lakhs. The depreciation on these assets in estimated as about Rs. 121.00 lakhs. The written down value of the assets cost to Rs. 147 lakhs or say Rs. 150 lakhs.

The administrative approval now sought for Rs. 1723.6 lakhs will be in suppression of all the estimates already sanctioned towards Ramagundam and Hussain Sagar Thermal Scheme and Nizam Sagar Hydro Electric Scheme, including City Reorganisation Scheme and installation of diesel sets at various places. This amount includes an amount of 684 lakhs being the expenditure incurred upto 31.3.56.

Load Forecast and Power Demand

The anticipated loads in the nine districts of the Telengana area are generally based on the load survey report prepared in the year 1956 by the Central Water and Power Commission. It can be seen, however, that conservative figures are taken for the loads anticipated to make them more realistic. The loads anticipated can therefore be easily realised. Under power availability purchase of Hydro Power to the extent of about 3,000 kW from Tungabhadra Zone 5000 kW from Machkund Zone is also taken for augmenting the power position in Telengana area.

Revenue Forecast

The gross revenue anticipated under this scheme is Rs. 82 lakhs in the year 1956-57 rising to Rs. 227 lakhs in the 10th year of operation.

The net return of the schme after taking into consideration the total capital cost and arrears of interest at a rate of 4½% per annum on capital expenditure comes to 4.9%.

As stated above a revenue rate of Rs. 370 per kW of demand per year is assumed for purposes of estimating gross revenue. This rate is considered as reasonable and easily realisable in view of the present level of gross revenue being above Rs. 520 per kW demand per year.

Cost of Power

The cost of power (in annas) at the power house 66 kV terminals at the different power houses in given below:—

First and tenth year's of operation

	1*st Year.*	10*th Year.*
(1) Ramagundam Power House	2.44	0.695
(2) Hussainsagar.	0.92	1.04*
(3) Nziamsagar Power House	0.27	0.287†

Productivity of the Project: Provision in the Second Five Year Plan Period

The Telengana Power Project as now finalised on the basis of 10 year period is an overall project for the entire Telengana area and covers the Hussain Sagar Thermal Scheme and Nizam Sagar Hydro Electric Scheme already executed and the Ramagundam Thermal Scheme with the necessary transmission lines, City improvement scheme and the establishment of diesel sets now on hand.

Although the project estimate covers the first five Year Plan Scheme either completed or continuing new Schemes under the Second Five Year Plan period including the spill over works into the Third Five Year Plan period and the productivity is judged on an over all 10 year period scheme, the scheme may be sanctioned as a second plan scheme especially as the different scheme reports submitted previously are not on the net return basis which is insisted upon by the Planning Commission. The execution of the scheme and incurring expenditure will be however regulated within the plan amount already approved during the Second Plan period and additional works taken up in the Third Five Year Plan.

Conclusion

The Telengana area is very much backward in the matter of electricity development. The per capita consumption is very low and is only 5 against the national average of 25 and is lower than the per capita consumption of 10 of erstwhile Andhra State area.

Note :—

* The slight increase in unit rate is due to the progressive decrease generation at Hussainsagar Power House on account of increased Hydro relief.

† Slight increase in cost per unit is due to additional capital outlay in 57-58 and 58-59 on improvements to the Nizamsagar Head works and consequent incaeasod working expenses.

[*Continued on page* 24

Load Survey and its Promotion in Andhra State

By B. P. SASTRY and I. BASAVARAJU

The ultimate success of the big hydro-electric projects depends mainly on the degree and the speed with which the load is developed. With the vast sums of money that are proposed to be spent on the various multi-purpose and river valley schemes all over the country, it is of utmost importance that rapid development of load is ensured so that the investment becomes productive very early and does not become unprofitable outlay, thus utilising all the equipments installed to the maximum saturation. The importance of load surveys for load promotion has been emphasised to achieve quick results on the hydro-electric projects. This paper deals with the method of load surveys and the promotional measures to ensure rapid load development, with special reference to the conditions obtaining in Andhra State.

Power load promotion depends upon a number of important factors like abundance of industrial potential, average purchasing power of the people, existence of scope for small cottage industries which can be stepped up only with a comparatively small outlay. With optimum coaditions the load development in initial stages is bound to be phenomenal. Propaganda on an intensive scale will also be necessary in case the area is relatively backward and has to be made electricity conscious. After a stage when the initial saturation point is reached, the rate of growth of load will tend to be less unless further load promotional measures are taken. These may comprise special facilities to existing consumers by way of concessional tariffs for off peak loads, rebates for improved load factors and power factors and other inducements which will help to sell more units for the same demand.

Load Promotion

The commercial extensions are normally considered remunerative and taken up for execution if the full capital cost of the extension is recouped by way of gross revenue *i.e.* revenue realised by sale of electric power within ten years. All major project estimates in the State like the Machkund Hydro-Electric Project and Tungabhadra Hydro-Electric Project which are for generation of power and afford bulk supplies at 33 kV and 11 kV sub-station terminals are worked out on net revenue basis taking into consideration the working expenses *viz.* Interest, Depreciation, Operation and Maintenance. These are normally considered remunerative if the net revenue at the end of the ten years operation period is not less than 3% on the total capital outlay plus arrears of interest in the 10 years period. As the borrowing interest rate is of the order of 5% the above returns do not fully cover the interest charges. Nevertheless, schemes on a net return basis of 3% are sanctioned as many other indirect benefits, which are not directly calculable, accrue on account of supply of electric power in the State. It is always ensured that a substantial basic load and revenue is available even in the first year before an extension scheme is launched. Further load promotion will improve the financial aspect of the schemes beyond the above period and with more load and revenue, the interest charges will be fully covered within a reasonable period beyond the above limits. This underlines the importance of fast and full load promotion for all electricity projects.

Present conditions in Andhra State

The Andhra State is backward in the matter of development of electricity. The per capita consumption in the State is very low being about 5 units (at the beginning of the First Five-Yeat Plan) as against 15 for India. Out of the 16,000 villages in the State, only 600 have so far been electrified. The power potential in the State is, however, substantial and the two major rivers Krishna and Godavari can between themselves develop over one million kW of power. This emphasizes the importance of proper load survey in the State. The pattern of load in Andhra State as at the end of 31-3-1953 is indicated below:

Industrial	..	57%
Lift Irrigation	..	9%
Domestic	..	17%
Commercial	..	1%
Public Lighting	..	4%
Miscellaneous	..	12%

It may be seen that bulk of the load is only industrial. The Andhra State is also backward in respect of industrial developments. A few further major industries are anticipated in the State during the Second Five-Year Plan. Specially negotiated tariffs are also offered to such bulk industrial loads. These bulk loads generally need little canvassing, as establishment of such industries depends mostly on the availability of raw materials required by the industry, land, trans-

port, water and other facilities. There may be some difficulty only in cases where conversion to electric drive is necessary; for example some of the rice mills which require steam for producing boiled rice. But this is not a serious problem in Andhra State at the moment considering that such industries are few.

In regard to the factors governing the rate of growth of power demand *viz.* the average income and education of the inhabitants and the industrial potential, Andhra is favourably placed. The average income, particularly in the delta areas of Godavari and Krishna and other urban areas is reasonably high. The industrial prerequisites in the form of reasonably good mineral wealth, transport facilities, labour and water supply exist in abundance in Andhara. Industrial development has so far been very poor, due to, *inter alia*, absence of cheap hydro-power.

Apart from the above factors, there is one significant feature in Andhra. It is a system of preplanned installation of small diesel and steam stations at various centres in the zones. Though continuously firm Machkund power is yet to be made available, the whole of Andhra area has been already covered by transmission lines and distribution networks and initial load development was carried out by pilot stations and supplemented by bulk purchase of hydro power from the neighbouring states. This has been in vogue for over a number of years now. There is a growing demand for power which it has not been possible to meet so far. This initial development of electricity by the pilot generating stations will facilitate a good rise in the load demand with the commencement of hydro-electric supply. Even in the rural areas so far covered the demand has been substantially stimulated and there is a large demand for additional power. These areas within the economic reach of the existing supply lines will therefore present a virgin zone for a faster load growth.

Load Surveys—Minor Extensions

The load survey on an organised basis is done mostly in rural and small townships. In these areas, the load consists of mainly irrigation pumping and small industries *viz*, flour grinders, rice mills cotton ginning, oil expellers etc.

There is a separate commercial staff incharge of load investigation and load promotion in Andhra State. The load survey is carried out on the basis of contracts with individual consumers of all classes *viz.* domestic, industrial and agricultural. The commercial staff for the Department contact the potential consumers individually, take applications, check up the requirements of horse power with the actual field conditions, arrive at the requirements of power as accurately as possible and include them in the extension schemes. Loads which are covered in the schemes relate only to existing houses, wells and operating industries. Prospective, low tension industries are included only in positive cases when the field officers are satisfied about the *bona fide* of the consumers' requirements.

A junior Engineer with one or two load surveyors form a convenient group for such surveys. The party visits a village and spends two or three days in collecting the load requirements with the co-operation of the local village officials *viz.* Munsiff, Karnam, Panchayat Board President, Members and other influential people of the locality. They draw up a list of wells with field survey numbers requiring electric power, small industrial loads, house service connections, street lighting etc. The condition of the existing wells is checked for the availability of sufficient water for pumping. The bona fides of the small industrial loads are checked as also the condition of houses requiring power. General information pertaining to the village or townships is also gathered in the following categories.

(*i*) Villages which are already having electric supply.

(*ii*) Villages which require electric supply for the first time.

(*iii*) Urban areas which are already having electric supply and

(*iv*) Urban areas which require electric supply a new.

A questionnaire drawn up for collecting the information in rural and urban areas is furnished in Annexures I, II, III and IV.

After collecting all information, applications are obtained from the prospective consumers. The location of the wells, loads etc. is marked in a map of scale 16″ to a mile and a general scheme is drawn up for distribution of electricity. The load forecast may be said to be realistic and very conservative as it is based on individual contacts with consumers and a first hand knowledge of the area.

A general scheme for rural electrification in the State has been drawn up for Second Five-Year Plan. This envisages extension of supply to 964 villages 16,090 numbers agricultural pump sets, 1,674 numbers small industrial loads, 50,000 house service connections and 14,180 street lights and contains in all 137 schemes with a total outlay of Rs. 6.33 crores. Some of these schemes have already been investigated and some are yet to be taken up. These will be planned for investigation and proposals finalised during the earlier part of the plan period. Load survey on a planned basis may therefore be said to have been initiated already in the State.

Load Surveys—Major Projects

For preparing the major project reports like the Nagarjunasagar Hydro-Electric Scheme, Sileru Hydro-Electric Scheme etc., a comprehensive load forecast for the entire State has been drawn up and the area to be fed by each power source is clearly defined. For this purpose it is proposed to divide the entire State into two power zones *viz.* (*i*) the Machkund-Nellore Zone comprising the northern districts of Srikakulam, Visakhapatnam, East Godavary, West Godavary Krishna, Guntur and Nellore districts in the North and (*ii*) The Tungabhadra-Chittoor Zone comprising Chittor, Kurnool Anantapur and Cuddappah Districts in the South. The above proposal is based upon the fact that there are only two major power sources for the present. All the other medium sized thermal stations and small diesel stations are only in the nature of nursery

or pilot stations which will have to be shut down and the respective areas covered by them merged in two zones proposed. The load and revenue forecast have therefore been prepared under the Second Five-Year Plan schemes under the above two zones. This load forecast for the Andhra State has been formulated with a view to examine the extent to which the schemes proposed under the first Five-Year Plan will meet the load demands and the additional generating capacity required in the projects in the Second Five-Year Plan. The load forecast takes into consideration the following aspects.

(*a*) *Existing loads.*—In the various areas *viz.*, Srikakulam, Visakhapatnam, Kakinada, Rajahmundry, Vijayawada and Nellore a normal annual increase for the next 10 to 15 years is provided after considering, potentialities, importance of the area, population, availability of raw materials for industries, etc.

(*b*) *Sanctioned loads awaiting connections*—Under this head, all schemes that have been sanctioned by the Government, Chief Engineer for Electricity, and Superinteding Engineers are covered.

(*c*) *Schemes under sanction.*—Remunerative schemes finanalised and awaiting sanction of competent authority.

(*d*) *Schemes investigated and under finalisation.*—These are expected to materialize from 3rd or 4th year of the second Five-Year Plan onwards depending upon the nature of load.

(*e*) *Schemes under field invesigation.*—These are expected to materialize after those covered by item above, and

(*f*) a reasonable increase in yearly demand due to incidence of new loads not covered by the above categories.

The power demands for each extension scheme are reckoned very conservatively as also the rate of growth of load. The incidence of actual demand is assumed to be 1/6 to 1/3 of the corresponding connected load figure depending upon the type of load. It is also assumed that this demand may rise to about 1/2 the connected load in about 5 to 8 years from the demand now adopted. To arrive at the demand under category of load a diversity factor of 1.2 is assumed. The demands in each area are added up and a further diversity factor of 1·2 with 10% line losses is assumed to arrive at the demand on the power station.

The capacity of the new power stations is determined by subtracting the existing effective generating capacity from the total demand arrived at as indicated above. This figure is 26 mW in 1955-1956 rising to 104 mW in ten years in 1964-1965, and 125 mW in 15 years in 1969-1970 in Machkund Nellore Zone. Similary in Tungabhadra-Chittor Zone, the load demand works out to 10 mW in 1955-1956 rising to 64 mW by 1964-1965 and 86 mW by 1969-1970. Thus for the entire State the load demand will be 36 mW by 1955-1956, 168 mW by 1964-1965 and 211 mW by 1969-1970

Measures to promote Load Building

The realisation of the above load would mean the rising of the per capita consumption in the State to 20 units at the end of Second Five-Year Plan. For the early realisation of these loads, load surveys are to be done on vigorous scale and load promotional measures undertaken. These measures are generally based upon the experience gained in the past 20 years, in the composite State of Madras, supplemented by the results of experience in the Andhra State after its formation.

The load promotional measures so far undertaken in Andhra State with a view to achieve speedy load development for the Machkund and Tungabhadra Hydro-Electric Projects in Mackund-Nellore and Tungabhdra-Chittor Zones are detailed below.

(*a*) As already indicated, special commercial staff carries out load surveys, estimates the load demands in various areas by direct contact with the prospective consumers and formulates schemes for distribution of electricity. Such organized commercial activity has been a tradition carried over from the composite Madras State where it has been in existence right from the inception of the Pykara hydro-electric project from the early thirties.

(*b*) Advance utilization of the major transmission lines constructed under large projects, by operating them at lower voltages initially for distribution of power, has been liberally adopted in Andhra. The 132 kV lines constructed between the Machkund and Vijayawada were till recently operated at 33 kV and were being utilised for load development in advance of the commissioning of Machkund Hydro Station and commencement of 132 kV operation. Advance load building of the areas covered by the Machkund and Tungabhadra Hydro-Electric Projects was achieved through pilot or nursery thermal and diesel stations in the areas.

(*c*) The tariffs in Andhra State have been simplified in 1955 and uniform and simplified tariffs on more rational and scientific basis applicable throughout the Andhra State have been evolved. Specially low tariffs are given for the agricultural pumping loads and cottage industries in rural areas. For domestic pump sets, tariffs for combined light and power have been introduced eliminating the necessity of separate wiring for lights and fans and domestic power appliances.

There is a provision in the departmental tariff structure for negotiation for low rates for large bulk loads. The alternative of kW demand rate is altogether eliminated and the tariff is based only on kVA demand which will give automatic benefit to the consumer for high power factor.

(*d*) For encouraging rural electrification, service connections are being given free to agricultural consumers and bonafide cottage industries. Special guarantees are generally not being stipulated in respect of domestic service connections.

(*e*) Rural consumers' co-operative societies would promote more utilisation of Power for the benefit of local community by way of group lift irrigation schemes etc. A few such institutions already exist in the State, and these have helped in promoting the agricultural pumping load.

The following load promotional measures are either

already proposed or are likely to be undertaken in the Andhra State in the next few years.

(*a*) As some spare hydro-power is likely to be available in the State in the next few years, propaganda measures are proposed to be adopted with a view to popularize use of power. Educating the prospective consumers in the utilisation of electricity especially in rural areas for cottage industries and agricultural pumping and domestic appliances, and publishing the activities and procedures of the Department from a major part of the enterprise.

(*b*) The scheme of "conversion fund" was in vogue in the composite Madras State. This envisages the grant of loans to the existing factories who are at present running on diesel or steam engines to enable them to purchase the electrical equipment required to utilize the newly developed hydro power. Further, to assist the factories owning their own power plant in changing over to departmental supply, a system of free supply of transformers for an initial period with option to hire or buy it outright at the end of that period was also in vogue. These two systems may have to be examined for adoption in Andhra as soon as surplus power is available.

(*c*) A system of assisted wiring could be provided to small domestic consumers at the cost of the Government and a suitable tariff to take this into account may be given.

(*d*) A system of hire purchase for domestic appliance in respect of domestic services may be introduced to promote domestic load in the system.

(*e*) Supply and erection of agricultural pumpsets at Government cost may be undertaken on a system of repayment of cost on easy instalments. This will relieve the burden from the shoulders of the prospective agricultural consumer considerably and will help in very rapid development of agricultural load which is of very high importance for improving the rural economy.

(*f*) Servicing of the pumpsets of agricultural consumers may be undertaken by the Department on a nominal monthly payment.

(*g*) A provision of Rs. 20 laksh is indicated in the Second Five Year Plan under Rural Electrification towards loans to agricultural and domestic consumers in the State.

(*h*) As rural electrification is admittedly expensive and unremunerative, expenditure on rural electrification could be advanced by the Centre to the State by way of interest-free loans to facilitate speedy rural load development.

Conclusion

This paper is intended to give a comprehensive idea of the load survey methods and its promotional measures adopted already and proposed tobe adopted in future in Andhra State. These measures may perhaps be considered for adoption in any other State which is on the verge of electrical development.

Appendix I

Questionnaire for village plants where electric supply is not extended to the villages

1. Distance of the village from existing 11 kV or 33 kV line.

2. No of tiled houses in the village.

3. No of public institutions in the village like schools, public offices, hospital, temples, churches and mosques which require electric supply.

4. (*a*) No of existing kerosene or petromax street lights in the village.
(*b*) No. of electric street lamps required.
(*c*) Total annual income of the Panchayat.

5. (*a*) Existing industries in the village: Rice mill—horse power of each, type of power now used for running, diesel or steam engine, condition of prime movers or boilers.

Any future mills to be set up, Type, H.P. of such mills. How many of such mills are prepared to use electricity ?

(*b*) Flour mills and other mills—Type of engine and horse power of each.

(*c*) Future mills proposed or to be set up.

Is capital available ?
Is the management by proprietor or limited company ?
What is the product ?
Is site selected ?

6. Existing cinemas in the village. Number of existing H.P. of engine set for each.
How many of them are willing to change over to electric supply ?
New cinemas proposed if any.
Is capital already collected ?
Is site already selected and work begun ?
How many of them are willing to take supply of electricity ?
Is management by limited company or proprietor ?

7. No. of surface wells in the village area, acres cultivated under each well.
Type of crop.
Depth of water from ground level.
Number of new wells likely to come up, number of acres likely to be cultivated under these wells.
The crops being raised at present on these lands.
Crops likely to be raised by lift irrigation.

8. No. of tube wells in the village area.
H.P of engine pumpset and size of tube wells.
Area cultivated under each tube well.
Type of crop.
New proposed tube wells.
The stage of work on the tube wells, whether the work is complete ?

Management of these tube wells, Government or private bodies.
Acreage likely to be covered by each.
Crops likely to be raised in the lands.

9. No. of existing artesian wells in the village area.
H.P of Engine pump set.
Area cultivated.
New wells proposed :
The stage of work. Whether the work is complete, acreage likely to be cultivated under each well. Type of crop to be raised.

10.(*a*) Cottage industries existing. Type and HP of engine. The product of the industry. The output of the industry. How many of them are willing to change over to electricity ?

(*b*) Cottage industries proposed to be set up.
Is capital collected ?

Managed by a private person or run on a co-operative basis.
Output of the industry.

11. Any other relevant information that may be provided.

Appendix II

QUESTIONNAIRE FOR VILLAGE PLANS WHERE ELECTRIC SUPPLY IS ALREADY EXTENDED TO THE VILLAGE

1. No. of tiled houses in the village.
No. of houses already electrified.
No. of houses willing to avail electric supply now.

2. No. of public institutions like schools, public offices, hospitals, temples, churches and mosques.
No. of them already electrified.
No. of them likely to take supply now.

3. No. of street lights in the village.
No. of street lights proposed to be extended.

4. Existing industries in the village

(*a*) Rice mills.
How many of them are run by electricity ?
How many of them are run by either disel or steam engine ?
Type and HP of such engines, condition of prime movers and boilers.
How many of such mills are prepared to change over to electricity ?

(*b*) Flour mills and other mills.
No. of mills in the village.
How many of them are run by electricity ?
Type and HP of the engines of the rest of mills.
The condition of the prime movers.
How many of them are prepared to change over to electricity ?

(*c*) Future mills to be set up.
Is capital collected ?
Is site selected and work of erection begun ?
How many such mills are prepared to take electricity for running the mills ?

5.(*a*) Existing cinemas in the village.
How many of them are receiving supply ?
How many of them have got their own generators ?
HP of each engine set ?
How many of them are willing to change over to electric drive ?

(*b*) New cinemas proposed if any.
Number.
Is capital already collected ? Is site already selected and work begun ?
How many of them are willing to take electric supply ?
How many of them intend to set up their own engine sets ?

6.(*a*) No. of existing surface wells in the village area.
Depth of water from ground level.
No of pumpsets operating making use of these wells.
How many of them are being run by electricity ?
How many of them are being run by oil engines ?
How many of these run by engines are ready to change over to electric supply ?
H.P. of each of such pump sets.

(*b*) No. of additional pump sets likely to be installed.
HP of each.
How many of them are willing to take supply of electricity ?

(*c*) No. of new wells proposed.
No. of pump sets to be installed under these wells.
HP of each.
How many are willing to take electric supply ?
The stage of work—whether the wells are already sunk.
If so the depth of water from ground level.
If the wells are not already sunk, the proposed sites of such wells.
The distance of such sites from the existing electric lines.

7.(*a*) No. of tube wells in the area. How many of them ares getting electric supply ?
How many of them have got their own engine sets ?
Type and HP of each.
The present condition of each set.
How many of them are likely to be changed over to power supply ?

(*b*) New proposed tube wells. Stage of Work—whether wells are completely sunk or not.
Management of tube wells, Government or private.
The location of the tube wells.
The distance of the sites to the existing electric mains.
Acreage to be cultivated by these wells.
Crops likely to be raised in these lands.
The present conditions of the land : whether waste land.
Whether pasture where cattle are grazed or already cultivated, and if so, the crops raised on them.

8.(*a*) Cottage Industries.
No. of such industries.
HP of each.
How many of them are using electricity ?
The product of the industry.
How many of them have their own engine sets ?
HP of each such set.
What are the products of the industries ?
How many of such sets are willing to change over to electricity ?

(*b*) Cottage industries proposed to be set up.
Is the Capital available ?
Management—Private, Government or Co-operative.
Out-put of industry.
HP required for each.
How many of them are willing to take electric supply ?
The distance of existing electric lines from the sites where such industries are to be located ?
Any other relevant information that may be provided.

Appendix III

QUESTIONNAIRE FOR URBAN AREAS WHERE ELECTRIC SUPPLY IS ALREADY EXTENDED

1. Is the town a major Panchayat or Municipality
Annual income of the Panchyat or Municipality ?

2. Number of public institutions in the town like schools, colleges, clubs, public offices, hospitals, temples, churches and mosques.
Number of them already electrified.
Number of them likely to take supply now.
Parks and other places of public resort using lights, radios etc.
How many of them are electrified ?
How many of them are likely to take supply now ?

3. Number of existing street lights.
Number of street lights proposed to be extended.

4. How many big hotels are there in the town ?
How many of them are using electricity for lighting, radio etc .?
How many of them are willing to take electric supply now ?

5. How many people own small domestic appliances such as heaters, refrigerators etc ?
How many people likely to instal appliances as above ?
How many people have small pumps upto 3 HP each for domestic purposes ?
How many pumpsets more than 3 HP each are used for non-industrial purposes such as for agricultural purposes ?
How many of them are likely to take electric supply ?
How many people own radios ?

6. How many large shops are there in the town ?
How many of them are having electricity for lighting and fans etc ?
How many of them are using neon signs ?
How many of them are willing to adopt neon signs ?

7. How many bakeries, confectionaries are there now ?
How many of them use electricity ?
How many of them are willing to take electric supply now ?
How many big laundries are there in the town ?
How many of them use electricity for cleaning, washing etc. ?

8. Number of cottage industries existing in the town.
Installed horse power of each such industry.
How many of them are using electricity ?
How many of them are having their own engine sets ?
Horse power of each such set.
How many of them are willing to change over to electricity ?

9. Number of workshops, saw mills, oil mills, rice mills, etc., now existing in the town and having installed capacity of less than 75 HP.
Horse power of each engine.
How many of them are taking electric supply ?
How many of them are willing to take electric supply now ?
How many of them have got their own generating sets for generating electricity for use in their factories ?
How many of them are prepared to take electric supply and keep their generating plant as stand by ?

10 Existing major industries (in which the installed capacity is more than 75 HP)
What is the product of the industry
How many of them are getting electricity now ?
How many of them are willing to take electricity supply now ?

11. Has the town got underground sewage system ?
How many sewage pumping installations are there ?
Capacity of each of such installations in horse power.
How many of them are run by electricity ?

12. Is there protected water supply system for the town ?
How many pumping installations are there now ?
Capacity in horse power of each of such installation.
How many installations are run by electricity ?

13. Any other relevant data that may be furnished.

Appendix IV

QUESTIONNAIRE FOR URBAN AREAS WHERE ELECTRIC SUPPLY IS NOT YET EXTENDED

1. Is the town a major Panchayat or Municipality.
Annual income of Panchayat or Municipality ?

2. Distance of the town from the existing 11 kV., 33 kV., 110 kV. or 132 kV. electric transmission lines.

3. Number of tiled or terraced houses in the town.

4. No. of public institutions in the town like schools, colleges, clubs, public offices, hospitals, temples, churches and mosques which require electricity.
Parks and other places of public resort using lights and radios.

5. No. of kerosene or petromax lights now existing.
Number of street lights required.

6. How many big hotels are there in the town ?
How many of them are prepared to take electric supply for their equipment such as radio, frigidaire etc. ?

7. How many domestic pumps are there in the town ?

How are they being run now ?
(*i*) Either by diesel ?
(*ii*) or by petrol ?
How many of them are likely to take electric supply ?
How many pumps of more than 3 HP are there used for non-industrial purposes such as gardening, cultivation, etc. ?
How many of them are likely to take electric supply ?
How many radios are there in service.

8. How many large shops are there in the town ?
How many of them are willing to take electric supply ?
(*b*) How many of them are now willing to adopt noen signs for advertisements ?

9. How many bakeries, confectionaries are there ?
How many of them are willing to take electric supply ?
How many big laundries are there in the town ?
How many of them use electricity for cleaning, washing, etc. ?

10. The existing cottage industries in the town.
Type and horsepower of engine used.
The product of the industry.
How many of them are willing to take electric supply ?

11. Number of workshops, saw mills, oil mills, rice mills, etc., now existing in the town and having engines below 75 HP. in total.
Horse Power of each engine.
Type of the engine—diesel or steam engine.
The present condition of prime movers.
How many of them are likely to change over to electric supply ?

12. Number of existing major industries (in which the installed capacity is more than 75 HP.
What is the product of the industry ?

13. What are the main agricultural commodities like cotton, groundnut, etc., grown in the rural areas around the town ?
Are there any minerals being mined actually now or known to occur but unexploited ?
Are the agricultural products and minerals being exported to other places ?
If cheap power is made available, is there any possibility of industries growing up like cotton ginning and pressing, oil mills, etc ?

14. How many cinemas are there in the town now ?
Horse power of engine set of each cinema ?
How many of them are willing to take electric supply and keep their generating sets as standby ?
Are there any new cinemas proposed ?
Is the site selected and work already begun ?
Is the management by a proprietor or by a limited Company ?

15. Has the town got underground sewage system ?
How many sewage pumping installations are there ?
Capacity in HP of each of such installation ?

16 Is there protected water supply system for the town ? How many pumping installations are there now ?
Capacity in HP of each of such installation.

17. Any other relevant data that may be furnished.

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Administrative set-up of Andhra Pradesh Electricity Department

The department is under the control of the Chief Engineer for Electricity, Andhra Pradesh, Hyderabad and the two additional Chief Engineers for Electricity, one stationed at Hyderabad and the other at Kurnool. The work in the department has been allocated amongst the three Chief Engineers mentioned above in the month of August, 1957 by the State Government.

According to the orders of the Government, the Chief Engineer for Electricity, Andhra Pradesh, is in direct charge of the following circles and works connected with those circles. He also deals with all general subjects such as tariffs, acquisition of electrical undertakings, etc.

(*i*) Superintending Engineer, Technical (Electrical)

(*ii*) Superintending Engineer, Technical (Civil)

(*iii*) Superintending Engineer, Machkund.

(*iv*) Superintending Engineer, Tungabhadra Hydro-Electric Scheme.

(*v*) Superintending Engineer, Construction and Operation, Telengana. This Officer has his headquarters at Hyderabad and is in charge of all works in Telengana area excluding the operation and maintenance of the 3 generating stations at Hyderabad, Nizamsagar, and Ramagundam and the 66 kV lines from Nizamsagar to Yerragadda and from Ramagundam to Siddipet and Warrangal. The Superintending Engineer, Construction and Operation, Telengana, is in charge of the distribution of power in the cities of Hyderabad and Secunderabad.

(*vi*) General matters of importance like Planning, Investigation, Designing etc., of new projects and budget.

(*vii*) Administration of the gazetted establishment of the Department will be under the Chief Engineer, Electricity, who will act in consultation with the two additional Chief Engineers in so far as the personnel working under the two Additional Chief Engineers are concerned. The administration of the non-gazetted staff liable to transfer throughout the State will, in the same manner, be under the control of the Chief Engineer, Electricity.

Additional Chief Engineer (Electricity) Hyderabad, will be in charge of the following :

(*i*) Superintending Engineer, Generation, Hyderabad, who looks to the operation and maintenance of the 3 Generating Stations, Hyderabad, Nizamsagar and Ramagundam, and the operation and maintenance of the transmission lines (66 kV) from Nizamsagar to Yerragadda, Ramagundam to Siddipet, and Ramagundam to Warrangal.

(*ii*) Superintending Engineer, Generation, Andhra. This Superintending Engineer is in charge of the operation and maintenance of the 4 generating stations at Machkund, Visakhapatnam, Vijayawada and Nellore and operation and maintenance of the transmission line from Machkund to Simhachalam and the Simhachalam Sub-station. He is also incharge of the operation and maintenance of the transmission line from Simhachalam to Rajahmundry and the Rajahmundry Sub-station.

(*iii*) Superintending Engineer, Operation, Anantapur. The jurisdiction of the Superintending Engineer extends throughout the Rayalaseema districts and Nellore district.

(*iv*) Electrical Inspectorate.

Additional Chief Engineer (Electricity), Kurnool will be in charge of the following :

(*i*) Superintending Engineer, Operation, Vijayawada. The jurisdiction of the Superintending Engineer extends throughout the coastal districts.

(*ii*) Superintending Engineer, Construction, East, Visakhapatnam. He is in charge of all major construction work related to transmission lines and substations in the coastal districts.

(*iii*) Superintending Engineer, Construction, West, Kurnool. He is in charge of all major construction work related to transmission lines and substations in Rayalaseema and Nellore districts.

The Additional Chief Engineers will themselves deal with all administrative matters relating to non-gazetted establishment in their respective charges except to the extent indicated in para 2 (*vii*) above.

The Additional Chief Engineer for Electricity, Hyderabad is the Chief Electrical Inspector to Government.

The Additional Chief Engineers (Electricity) will also correspond direct with the Government and Accountant General in respect of matters in their charge.

Continued from page 32

Tungabhadra Hydro-Electric Scheme

III. *Hampi Power House* :

1. F.R.L. of Forebay.	1519.83
2. Storage capacity.	28 Million C.Ft.
3. Minimum Draw down level.	1505.00
4. Length of L.P.P.L.	2781.25
5. No. of L.P.P.L.	Initial 1 and ultimate 2.
6. Internal dia. of L.P.P.L.	18′-0″ ½″ thickness.
7. Maximum Discharge.	2250 cusecs.
8. Maximum velocity.	8.8′ per sec.
9. Surge Tank.	Steel tank of the differential type.
10. Surge Tank outer shell.	60′-0″ internal diameter.
11. Surge Tank Riser.	18′-0″
12. Surge Tank Height.	About 60′-0″
13. Penstock pipes.	2 Nos. initial and 4 Nos. ultimately.
14. Penstock length.	About 30′-0″
15. Penstock Internal diameter.	12′-0″ of ½″ to 9/16″ thickness.
16. Penstock Maximum discharge.	1128 cusecs.
17. Penstock Maximum velocity.	About 10′-0″ per second.
18. Length of Power House.	200 feet.
19. Width of Power House.	63′-0″
20. Weight of Power House.	About 50′ above generator floor level.
21. Gross head.	104 ft. to 119 ft.
22. Turbines.	Vertical Reaction. Type initial 2 Nos. Ultimate 4 Nos.
23. Generators.	2 Nos. of 9000 kW for the initial stage and 4 Nos. ultimately.

ANNEXURE V.

Engineers prominently associated with the execution of the Tungabhadra Hydro Electric Scheme

1. Sri G. Sundaram	Chief Engineer Electricity, Composite Madras State.
2. Sri. B. R. Somayajulu	Chief Engineer (Electricity), Andhra Pradesh.
3. Sri. G. Chandy	Chief Engineer (Electricity), Mysore.
4. Sri J.L.D'sa	Chief Engineer (Electricity), Mysore.
5. Sri P. M. Chengappa	Superintending Engineer.
6. Sri C. V. S. Narasimha Rao	Superintending Engineer (Civil).
7. Sri V. Pappu	Superintending Engineer, Technical, (Electrical).
8. Sri V. Parvathesam	Superintending Engineer, Technical, (Elecl.).
9. Sri Ramachandra Setty	Superintending Engineer (Electrical).
10. Sri D. A. K. Chary	Executive Engineer (Electrical).
11. Sri S. Bistappa	Executive Engineer (Electrical).
12. Sri B. Atchutharamasarama	Executive Engineer (Civil).
13. Sri C.V. Rangaswamy	Executive Engineer (Civil).
14. Sri H. Raghavendra Rao	Executive Engineer.
15. Sri M. A. Rahman	Executive Engineer.
16. Sri H. Sundaravaradachary	Executive Engineer.
17. Sri H.S. Narayanarao	Executive Engineer.
18. Sri P. V. Keshavaiah	Executive Engineer.
19. Sri C. R. Parthasarathy	Executive Engineer.
20. Sri K. Ramabrahmam	Executive Engineer.
21. Sri Ch. Ram Rao	Divisional Engineer.
22. Sri T. S. S. Subba Rao	Executive Engineer.
23. Sri Y.S. Rao	Executive Engineer, Electrical & Mechanical.
24. Sri B. P. Sastry	Executive Engineer, Electrical & Mechanical.

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I. P. K. Menon, hereby declare that the particulars given above are true to the best of my knowledge and belief.

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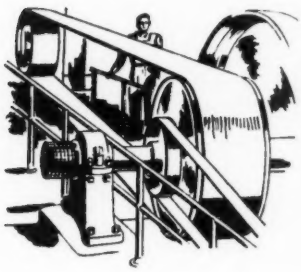

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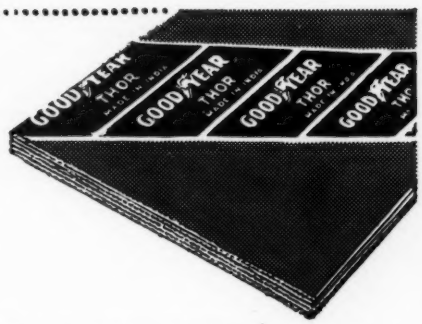

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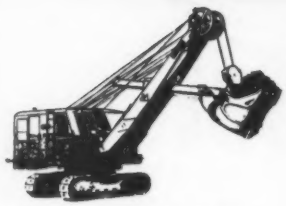

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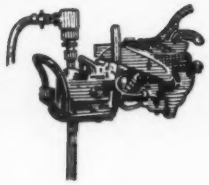

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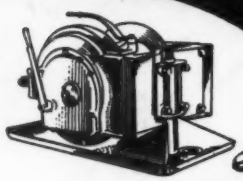

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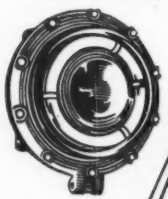

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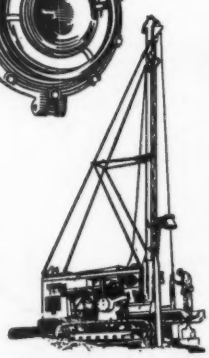

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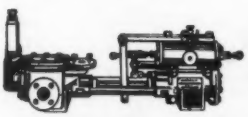

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